MECHANICAL ENGINEERING

NOVEMBER 1946

A.S.M.E. ANNUAL MEETING—NEW YORK, N. Y.—DECEMBER 2-6, 1946

LOW-COST POWER

B & W PERFORMANCE FILE #17

CONNECTICUT POWER CO.
STAMFORD, CONN.

OBJECTIVE: To balance installation costs, maintenance expense, and thermal efficiency to give the *lowest over-all* cost of electrical energy. . . .
—from statement of engineers BEFORE installation.

APPROACH: Addition of a new base-load unit consisting of a 25,000-kw. turbine and a 250,000 lb. per hour B&W Radiant Boiler.

% OF TIME ON LINE: Here is the "on-the-line" record of this unit for complete years since its installation:

1942 . . . . . . 90.9 1944 . . . . . . 92.0
1943 . . . . . . 89.9 1945 . . . . . . 93.3
Four-year average 91.5

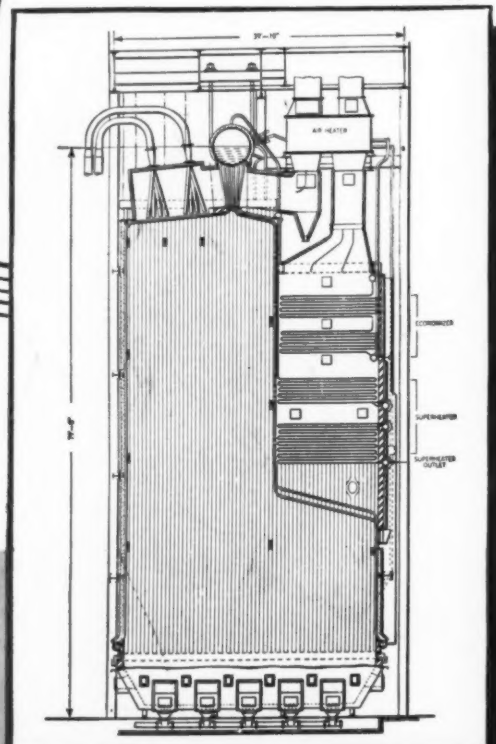
CAPACITY FACTOR: 1942 . . . . 89.2 1944 . . . . 90.4
1943 . . . . 87.9 1945 . . . . 90.0
Four-year average 89.4

OUTAGE TIME CHARGEABLE TO BOILERS: One-tenth of one per cent since put into operation in October 1941.

CONDITION: No slag around burners, on side or rear walls in burner area, or in superheater. Slag formations elsewhere negligible or easily removed without shutdown. Original superheater tubes still in service. Turbines have never required cleaning and have shown no deposits at normal inspection periods.

SATISFACTION: The performance record of B&W boilers at Stamford is further evidence of the dependability, continuity of operation and low ultimate cost that is built into all B&W units, and in the words of engineers of the Connecticut Power Co. after four years' operating experience with this unit: "A conservatively designed unit conservatively run pays dividends."

Also at Stamford are four 600 hp. B&W Boilers and two 180,000 lb. per hr. B&W Boilers.



B&W Radiant Boiler installed in Stamford Station of Connecticut Power Company in 1941. Maximum continuous steam capacity—250,000 lb. per hr. at 975 psi and 915F. Designed for vertical firing with either pulverized coal or oil.

B&W

Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.

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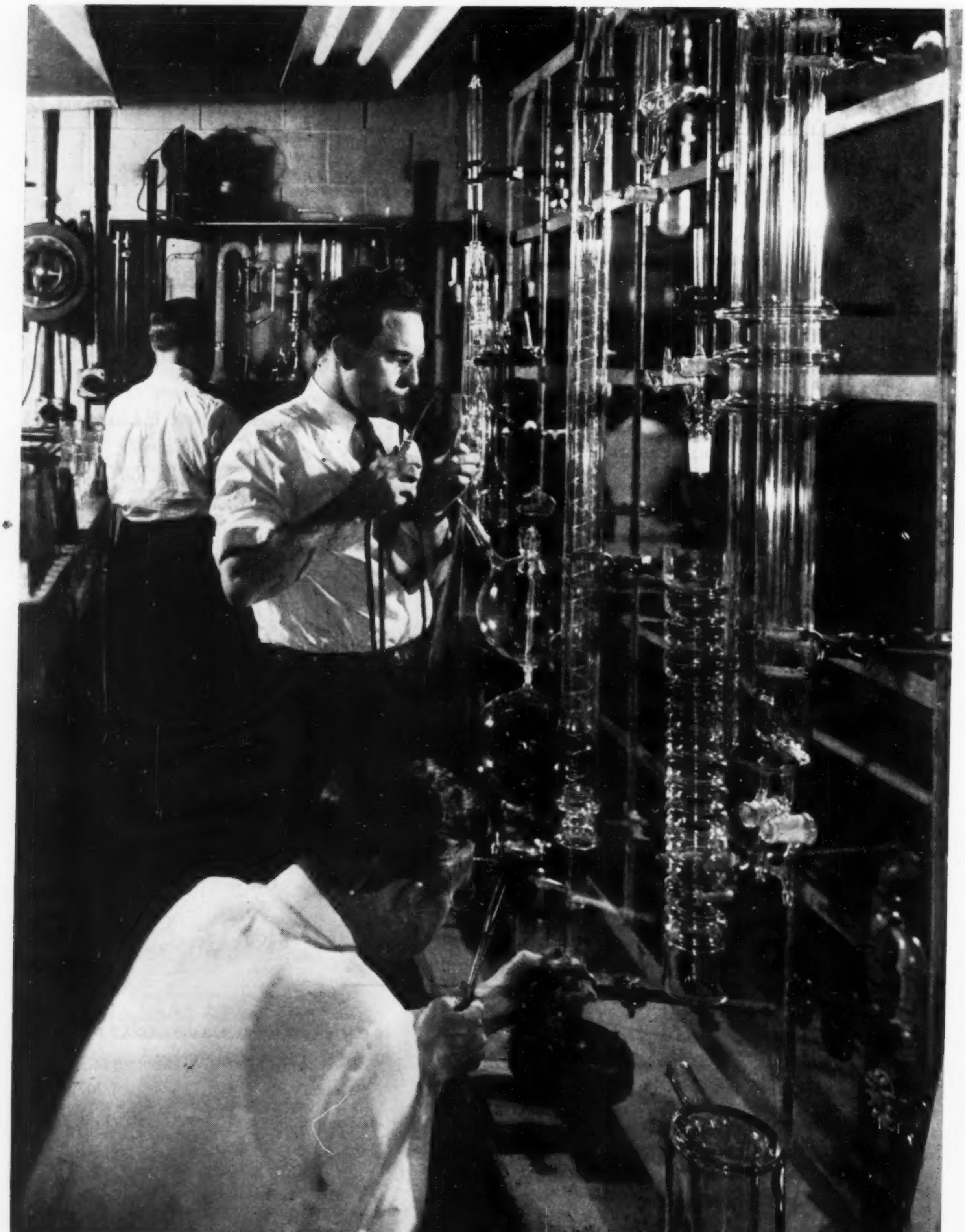

Gulf Research and Development Co.

Glass Blowing Becomes a Science Essential to Modern Research

Volume 68
No. 11

MECHANICAL ENGINEERING

November
1946

GEORGE A. STETSON, *Editor*

R. L. Sackett

ROBERT LEMUEL SACKETT, who died on Oct. 6, 1946, was possessed of varied talents which he used fruitfully throughout his long life in the service of others and for the recreation and satisfaction of his own noble spirit. With him the approach of old age was accompanied by no weakening of his mental vigor and no abatement of his interest in young men and their problems. He was typical of that small but enviable group of schoolmen whose contacts with youth keep them eternally young in spirit and outlook. When he laid down his duties as dean of engineering at the Pennsylvania State College and went to New York to live, the wisdom and experiences of a long and useful career were exercised in the tasks he performed there with the Engineers' Council for Professional Development and The American Society of Mechanical Engineers. When the war ended and hundreds of young engineers were released from the Armed Forces to resume their interrupted professional careers, it was Dean Sackett who, as a member of the A.S.M.E. staff, discussed their problems with them, in much the same manner in which he used to talk with students at Penn State, and advised them what course they should follow.

From the Quaker tradition in which Dean Sackett was reared he acquired a gentleness and understanding combined with an unfailing regard for truth and the principles of noble living. His large frame and splendid physique lent him an imposing appearance. His face reflected a stern dignity, but a warm and friendly spirit within softened this sometimes uncompromising aspect when he smiled and when he was with those whom he knew well. Self-disciplined to such an extent that he seldom displayed strong emotions, he faced life with courage and fortitude. The sorrows and discouragements of living, of which he had his share, left him unmarked by bitterness. He appeared to have within him resources of strength and refreshment. He faced life squarely, without complaint, and readjusted his life and his plans with stoical realism whenever conditions demanded.

Confidence and optimism are unsatisfactory and frequently misused words to apply to Dean Sackett's qualities as a man. Yet he certainly inspired these qualities in others by the calm sanity of his views. There was too much of the stern realist and unwillingness to compromise with principles and the truth, to apply these terms to his character in the popular hedonistic and mundane sense. Where men with less moral fiber would speak evasively or in an effort to please, Dean Sackett gave his opinion and administered reproof like an impartial judge. Without malice, although frequently with indignation, he spoke the truth as he saw it. But he uttered criticism of others only when occasion demanded that he no longer remain silent, and if there were envy and meanness in his mind, he never betrayed them.

The accomplishments of Dean Sackett in engineering and education will be recorded elsewhere. Suffice it to say here that he distinguished himself in both, and in recognition of his ability in the latter field he was awarded the Lamme medal of the S.P.E.E., given every year to honor a great teacher of engineering. He was active in the professional societies of which he was a member, giving of his time and energy to their causes, for he was not a man to receive only. His role was that of worker and leader.

When he retired from the deanship at State College, Dean Sackett took up residence in New York. In a pleasant room that faced the south, he and Mrs. Sackett, who predeceased him by a few years, entertained their friends. He confessed once that he found living in New York brought to him more friends than he would have seen, save for his fellow townsmen, if he had remained at State College. At the Engineers' Club he was a welcomed and agreeable companion. His wealth of experience provided him with innumerable anecdotes, and his contributions to table talk were spirited and illuminating. Relaxed and refreshed, he exhibited a joviality that belied his dignified appearance.

Dean Sackett's work in New York lay in two fields. For a period of several years he shared with C. F. Scott the E.C.P.D. offices. Under his leadership the Council's work in the field of student selection and guidance had serious purpose and expert direction. It was his belief that only young men qualified by aptitude, special talents, and sound training should take up the study of engineering—that it was quite as important to avoid a waste of time on the education of the unfit as it was to give every encouragement and opportunity to young men of marked promise. With the A.S.M.E., during the years when service in Washington caused extended absence of the Secretary, Dean Sackett took over countless jobs relating to the joint activities with other societies and was always available to talk with visitors, old and young, member and nonmember, who called at headquarters. To the staff he gave liberally of his time and wisdom. To him its members turned in many matters, particularly those which involved educational theory and practice and a broad knowledge of men and professional affairs.

What many of his friends will remember most vividly about Dean Sackett will be his hobbies. Like many other engineers, some of whom derived their inspiration from him, he liked to paint and did creditable work in water

colors. One can only imagine what the exercise of this artistic talent meant to a man of Dean Sackett's self-controlled temperament, and how refreshing to him it must have been to interpret, through the skill of his hand the acuteness of his eye, the beauty that he found wherever he looked. And there was his boating, another hobby which persisted until his death, in which relaxation came not by undisciplined surrender to moods and emotions, but in a matching of wits with the wind and currents, and in extending the control he had of self to the control of his yawl. In both his art and his boating, as in his work he retained in himself the mastery of the mental and physical conditions in which he found himself.

Boston Meeting

IT is to be hoped that H. M. King and his fellow committeemen, who were responsible for the conduct of the 1946 A.S.M.E. Fall Meeting in Boston early in October, and Mrs. C. Harold Berry and her colleagues, who were hostesses to the women present, were as well satisfied with their efforts as were the 1500 members and guests. From every angle the meeting was significant, informative, and enjoyable, and in some respects it was outstanding. A considerable number of able speakers addressed the luncheons and dinners; the excursions and plant trips appealed to a variety of tastes and were skillfully handled; the technical program, although extensive, was also diversified; and the conferring of honorary memberships on two colorful and distinguished New Englanders introduced into the banquet the intimate quality of an old-home week.

Although officially the 1946 Fall Meeting was a national meeting of the Society, its setting in New England and the frequent references to New England led many persons to miscall it a regional meeting. To engineers whose roots are deep in New England, and there are many, this emphasis was appealing, and to non-New Englanders it must have been revealing. Mr. Blackall's opening address, which will be found in this issue, and Admiral Deyo's tribute to New England's contribution to the winning of the war, which will appear in another issue, were convincing testimony to the virility of New England's industries and its engineers. Mr. Klein's address at the banquet, which will be published in December, was also a tribute to New England engineers and their part in the development of the atom bomb. New England's educational institutions were ably represented, and in this connection mention should be made of Arthur L. Williston, who received a fifty-year membership button at the banquet. Mr. Williston's life has been spent in the important field of the technical institute from which industry draws much of its skilled manpower. And what more typical of New England is there than textiles, which on one occasion at least stole the show at the Boston Meeting?

For several years the public has been led to think of New England in terms of vacation land—its beaches, woods, mountains, and lakes, its rivers and streams, its beautiful and intimate scenery, and its neat villages with green common and white church spire. In the New World New England was the birthplace of industry and institutions and of men and women who went forth to settle the West, taking with them their trades and skills, their institutions and traditions, there to bring forth towns and cities from one ocean to the other. Because the nation has grown so large, New England has appeared to shrink by comparison, yet statistics show that it is more than holding its own industrially; and the evidence at Boston was to the effect that New England still breeds leaders of men and leaders of industry and engineering.

With the great expansion of industry in the South, where some of New England's industries have prospered, the Middle West, where New England's mechanics built up great machine-tool plants, and the Pacific Coast, where New Englanders went generations ago to seek their fortune, New England has been forced to pass through a period of readjustment to changed conditions from which it is emerging with credit and revitalized industrial strength. Originator of a governmental organization that the nation itself adopted, originator of educational systems that have given us the public-school system, originator of much of the industrial legislation which aids and safeguards the workers, New England has led the states in times past and has spread its influence in economic and social progress throughout the land.

It was proper that New England should have been honored in Boston and that her historic places and her industries and institutions should have been exhibited to mechanical engineers. The engineers of Boston were guilty of no false pride when they planned their meeting and invited their leaders to address the Society. In a nation confused with false doctrines which originated in oppression in alien lands, it is refreshing to contemplate the virtues of a region that was founded by people who had fled from oppression, who believed in the dignity of the individual, who were never afraid of hard work, who practiced thrift and forbearance, whose government was based on the consent of the governed, and who had high regard for spiritual values.

New York in December

IN spite of rumors to the contrary, the 1946 Annual Meeting of The American Society of Mechanical Engineers will be held in New York, with headquarters at the Hotel Pennsylvania.

The program and announcement to be found on pages 997–1004 of the A.S.M.E. News Section of this issue will indicate imperfectly the plans for what promises to be the largest meeting ever held by the Society. Prompt action in making hotel reservations is urgently imperative. Any engineer who wishes to be present should make arrangements without delay.

With the ending of the war attempt has been made to provide preprints of technical papers to be presented. A list of preprints that had been assured at the time of going to press will be found on page 998.

A Plea for HIGHER STANDARDS *in the* ENGINEERING PROFESSION

By FREDERICK S. BLACKALL, JR.

PRESIDENT AND TREASURER, THE TAFT-PEIRCE MANUFACTURING COMPANY, WOONSOCKET, R. I. MEMBER A.S.M.E.

I consider it a great privilege to welcome the members of The American Society of Mechanical Engineers to its 1946 autumn meeting in this historic setting but a stone's throw from the Boston State House, which, as you know, was characterized by the elder Oliver Wendell Holmes as the Hub of the Universe. Since the field of activity of a mechanical engineer is no longer earth-bound, but now transcends both space and time, it is an appropriate springboard from which to launch the Society's program and policies for the months and years ahead.

NEW ENGLAND ON THE MARCH

I am here today in two roles—in formal guise, as president of the New England Council, more intimately as a fellow member of the Society. In the former capacity, I extend to you a cordial welcome to New England and urge you to tarry awhile after the meeting is over, to see at firsthand not only the beauties of New England, which make it such an outstanding recreational area, but to sense the spirit of progress and vigorous activity which makes New England one of the foremost industrial areas of the world. Let no one think that within these boundaries the glories of the past overshadow the promise of the future. The New England spirit is too little understood by our brothers from other parts of the nation. New England is on the march, I assure you, and if our parade is less noisy and attended by less fanfare than that of some others, it is no less sure and certain. With less than 6.4 per cent of the nation's population, New England produces nearly 9 per cent of the nation's industrial output. Its total production is at an all-time peacetime high. Indeed, New England's constant advance is too often obscured by statisticians who point out that New England loses industry on occasion to other areas. Since New England started out with virtually 100 per cent of the nation's industry and has itself been among the most active sources of venture capital and manpower in the building up of other areas of our nation, such statistics have little significance except to show that New England, too, is an active part of a vigorous and growing nation. In terms of wholesale and retail markets and population, Boston is the nation's fourth metropolitan area, running well ahead of all other cities in the country except New York, Chicago, and Philadelphia, in the order named. The region has one of the highest per capita incomes in the country. The buying power of the typical New England family is equaled only by that of the Pacific coast, that well-known paradise of spendthrifts, and is greater than that of any other region of our nation. Our industries are growing, our management is progressive and forward-looking, our industrial policies competitive. Small wonder that new plants are springing up hereabouts or that manufacturers in the West and South are increasingly using New England industry as an important source of supply. Don't make the mistake of selling New England short!

It is appropriate that I should tell you these things in my role as chief executive of the New England Council, but I have another and, to the Society, I think, more serious message for you here today in speaking simply as a fellow member of the A.S.M.E. My association with the Society extends back over more years than I like to count, and yet it seems only yesterday that I first proudly accepted membership on one of the Society's standards committees and first hung on my watch chain the Society's insignia, which I have carried ever since. Son of an engineer, born and reared in a technical environment, I held the A.S.M.E. in such high regard that I am sure I was quite as proud of my first committee assignment as I was recently when you nominated me to the Council. My work in the Society has been devoted primarily to co-operative effort in the development of engineering standards, and thus it is natural that I should think first of the A.S.M.E. in terms of standards. So I want to talk to you about a matter which I regard as vital to this old Society, and that is the maintenance and strengthening of our standards of membership and, as a corollary to this, the protection of the standards of the engineering profession itself.

THE TERM "ENGINEER" MISUSED

I know of no word in the English language which is more abused and misused then the term "engineer." It is a pity that real engineers cannot copyright the word in some such manner as the real-estate men coined and copyrighted the term "realtor" to prevent its prostitution by the incompetent and the unworthy; but, alas, the abuse is of too long standing. In the course of my business activities I am called upon by a long list of "engineers," most of whom couldn't even read a slide rule. Yesterday a "profit and loss engineer" sent in his card. It developed that he was an accountant. And of course there aren't any peddlers any more; they have all become "sales engineers." To one who became an engineer the hard way and looks with justifiable pride upon his profession, this is just a little bit sickening. But we don't have to condone it and we shouldn't.

Of late years the self-styled engineers of this stripe have grown bolder in their appropriation of the perquisites of the profession, and we now find all manner of "Engineering Societies" rising about us. It seems to me that I hear of a new one at least once a week, though I may exaggerate; but I am impressed with a common characteristic of these organizations—the one thing they are after is members. The qualifications seem to be possession of a fountain pen and a willingness to part with the initiation fee.

I have no fear that this society, with 65 years of eminent and distinguished service behind it, will fall into any such error, but I warn you, gentlemen, the pressure is on. I find a growing effort on the part of unqualified "engineers" to seek admission to our portals, and, alas, too often a complaisance on the part of good-natured but short-sighted members to aid and abet the gate-crashing. Though we want all of the duly qualified members we can get, there should never be the slightest relaxation of the strict interpretation of the requirements for membership in this Society. As the years go on, I should prefer to see the

An address presented at the 1946 Fall Meeting, Boston, Mass., Sept. 30–Oct. 3, 1946, of The American Society of Mechanical Engineers.

requirements made more rigid, rather than less. Quality and worth will always attract a following.

Especially do I urge that there be no compromise with the standards of professional competence established for admission to the grade of Member. In making this suggestion, I draw no invidious comparisons between our Members and our Associates. The contribution of Associate Members to our Society has been a very real and a very great one. Indeed, the inclusion on our rolls of men of competence, who have a record of leadership in fields related to mechanical engineering should be encouraged. Their presence and co-operation lend elements of breadth and balance to our society, which is in every sense desirable. But I hold that the term, "Member of The American Society of Mechanical Engineers," should be something like a college degree which can be won only by meeting satisfactorily certain rigid and formal stipulations. The possession of such a degree constitutes notice to the world that the holder has met such stipulations. His other qualifications, no matter how eminent, do not and cannot entitle him to its use. Membership, in the grade of Member, in The American Society of Mechanical Engineers should constitute notice to the world that the holder of such membership is, in fact, a competent engineer. If we guard our portals jealously we shall enhance not only the standing of our Society, but of its Associate and Junior grades of membership as well.

RAISE STANDARDS OF ENGINEERING EDUCATION

I have long felt indeed that the standards of engineering education should be raised, that the requirements for a mechanical-engineering degree should be made more stringent. In my judgment, engineering should be placed on a parity with medicine, the law, and the other learned professions. Under such a procedure, he who would qualify as a technical graduate would first be required to complete perhaps either three or four years of pre-engineering-college work, with considerable emphasis on the pursuit of studies in the liberal arts and the humanities. During the pre-engineering course, the basic requirements in mathematics, and possibly in physics and chemistry, also could be dispatched This would be followed by either two or three years of specialization in the chosen field of engineering. On completion of the first four years of college work, the student would receive the degree of Bachelor of Science, or its equivalent; on completion of his graduate work, he would receive a suitable engineering degree.

Beginning with the fall term this year, Cornell University is taking a step in this direction, with a five-year engineering course, in which liberal emphasis is placed on such subjects as English, economics, psychology, the history of modern civilization, etc. Some courses will be included as well in phases of management, industrial organization, and finance. By adding a year to the usual engineering curriculum, it is intended to avoid any dilution of the technical courses which are, of course, prerequisite to sound engineering training. In my opinion, this is a highly constructive step. It is not such a far cry, either, from the situation which exists today in many of our leading engineering institutions. I understand that immediately prior to the war 33 per cent of the matriculants at the Massachusetts Institute of Technology were either college graduates or college transfers. This ratio is being altered temporarily by the limitations placed upon applicants in order to provide for the veterans' postwar educational program. With a return to normal conditions, I believe that an increasing number of engineering students at the better technical schools will seek some pre-engineering training before completing their technical curriculum.

It may be argued that any such arbitrary raising of the educational standards of our profession would exclude from its ranks many who could not afford, in time or money, or both, to meet the requirements. Half a century ago the same objections were voiced when it was proposed to raise the standards of medical education, but who today will argue that the step was not a wise one?

To an increasing extent the engineer is called upon to exercise broader functions than those of pure research and design or the direction of technical processes. As he reaches the higher echelons, as our military friends love to put it, his duties increasingly embrace management, economics, labor and social problems, finance, and above all, the necessity for effective contact with all manner of people. Adequate preparation for such responsibilities requires breadth as well as depth.

Indeed, one of the minor tragedies of technical life is the presence in our ranks of too many hack engineers, men who somehow have wangled a technical degree, or may even have completed the formalities with apparent merit, but who simply never can and never will measure up to what you and I mean when we speak of a competent engineer. These poor souls go through life ever in a rut, frustrated and disappointed, feeling, perhaps with some justice, that they have been sold down the river because they have been through the diploma mill but simply cannot make the grade. A system which permits this to happen to an extensive degree does no good either to the profession or to the victims of the system.

Can anyone doubt that the engineer who has had an opportunity to acquire broad interests, more catholic tastes, the ability to read and appreciate good literature, and above all the power of self-expression, orally and on paper, will be a better and more effective engineer? One of the shortcomings which many of our members, though fully competent in their professional fields, would be among the first to admit is a certain inarticulateness. Too many others are narrow in their outlook, because of overspecialization beginning at their most impressionable age. Is it surprising that such men should find it difficult to avoid getting in a groove? Yet there is no profession whose members seem to possess historically greater potentialities for enjoyment of the arts and the humanities as avocations than that of the engineer. It has been true from the days of Leonardo da Vinci, who was no less capable a mechanical engineer than he was an artist and a sculptor. I remember with pleasure a display of canvases at an Annual Meeting of the Society in New York a few years back, every one of which had been painted by a member of the A.S.M.E. There is no broader, more intelligent, or intellectually more delightful conversationalist than an all-round engineer; and per contra, perhaps never a worse bore than a hack.

DEVELOP AND TRAIN NATIVE APTITUDES

I do not imply for a moment that the only way to secure an education is to go to college, or that the technical graduate who has had no more than four years of straight mechanical engineering may not develop into a broad-gaged, well-informed person of wisdom and breadth of vision. One need but point to this audience to give the lie to any such calumny. Neither do I imply that every hack engineer, who has ever been hatched out by a technical school, would have been a Daniel-Come-to-Judgment had he had three or four years of education in the liberal arts first. You can't make a silk purse out of a sow's ear. But you can make good men into better men by proper training and development of their native aptitudes, and that is what I am pleading for.

Beyond this, I would urge every member of our Society to take an active part in community affairs. The discharge of one's duties to society partakes of some of the attributes of a

(*Continued on page 960*)

SELF-TAPPING SCREWS

Fastening Strengths in Various Materials

By A. C. MILLARD

MEMBER OF TECHNICAL STAFF, BELL TELEPHONE LABORATORIES, INC., NEW YORK, N. Y.

THE use of self-tapping casehardened screws for various fastening applications has increased considerably during recent years. Self-tapping screws are produced in two general types, namely, the thread-forming types, in which the screw forces its way into the nut material forming its own thread, and the thread-cutting variety, wherein the screw cuts a thread into the nut material by virtue of slots cut into the entering point of the screw. Also, each type of screw is made with modifications of the basic design to meet the requirements of some particular class of work. This paper deals with the fastening strengths of the two basic types of self-tapping screws, namely, the thread-forming type, commonly known as the Type Z, and the thread-cutting variety commonly known as the Type F or Type 1, 2, or 9, according to manufacturer.

In the design of apparatus under present conditions it is often necessary to take full advantage of the available strength of screw fastenings, thereby reducing weight and size as much as possible.

The information given herein is the result of fastening-strength tests of self-tapping screws in various materials which were carried out by the author at the Bell Telephone Laboratories, Inc. The work is by no means complete but it is hoped that it will prove of some value in its present form.

NEED FOR INFORMATION ON SELF-TAPPING SCREWS

The need for fastening-strength information for self-tapping screws became increasingly important during the past years when speed and simplification of assembly procedures were necessary. Also, in some cases a stronger screw in a small size was required. Here a self-tapping screw usually met the condition due to the increased strength of these screws as a result of their casehardening.

The intelligent use of self-tapping screws for fastenings requires the consideration of five types of stresses, namely: (1) torsion, (2) tension, (3) impact, (4) shear, (5) fatigue.

These stresses should be considered with respect to the function of the completed apparatus as well as with respect to the assembling of the apparatus in manufacture. The data on the attached charts portray the strength of fastening of selected sizes of Type Z and Type F self-tapping screws in several lengths of thread engagement in various metals and nonmetals under tension, torsion, and impact conditions. The charts also show the straight shear and impact shear for the screws alone. Each value given is the average of at least five determinations. The lead holes used for each size and type of screw were those recommended by the screw manufacturer.

No data are presented on the fatigue of self-tapping screws in the smaller sizes. Information as to the effect of fatigue on large-size standard machine-screw threads has been published from time to time. A summary of the literature on this subject was published a few years ago.[1]

METHOD OF CONDUCTING TESTS

The torsion values were determined on a pendulum-type torsion test machine, shown in Fig. 1, which was built for this purpose. The load was applied at the rate of $1^1/_2$ rpm. The screws were assembled in a hardened-steel fixture using the material under test as a nut. Each nut was provided with the proper lead hole. The material under test was held in a calibrated fixture while torque was applied by a screwdriver to the head of the screw. The test was continued in various material thicknesses until the fastening failed either by stripping of the nut, stripping of the screw thread, or the breaking of the screw.

In using the torsion-test data, consideration must be given to the length of the screw thread engaged, and the material and finish of both the screw and the material in contact with the head of the screw.

In using a self-tapping screw as a clamping medium, friction is developed between the head of the screw and the surface upon which it bears, as well as between the screw and the material into which it enters. The value of the force required to overcome the friction under the head of the screw depends upon the additive finish on the surfaces involved and the surface roughness of these surfaces. The value of the force required to turn the screw into the nut material depends upon the finish on the screw, the nut material, and the size of the lead hole in the nut material. The torque values reported in this paper are the sum of these two forces plus the actual torque required to break the screw or strip the nut where such failure occurred. In general the maximum thickness of nut material used was that recommended by the manufacturer for the particular size of screw.

The head and thread friction are present in any loosening of a screw fastening and, obviously, the higher these friction values the less will be the tendency of the screw fastening to loosen. In the case of self-tapping screws the thread friction is much higher than in the case of standard machine screws due to the closer mating of the screw thread and nut. Once a fastening is tight, any failure of the screw is usually due to tension, shear, or fatigue stresses. In the data presented herein, a smooth hardened steel block without additive finish such as plating, etc., was used under the head of the screw. The self-tapping screws tested were unfinished steel screws heat-treated. The variation in the coefficient of friction of the various finishes used on screws, etc., should be given careful consideration in the choice of screws used in fastenings.

The tension values reported were determined on an Amsler testing machine of 20,000 lb capacity using the 2000-lb scale, the tension being applied between the material under test and the head of the self-tapping screw at a rate equivalent to a free head speed of 0.2 ipm until failure of the fastening occurred.

The impact values reported were determined by the use of a fixture in a pendulum impact testing machine of 50-ft-lb capacity, shown in Figs. 2 and 3. The fixture used was calibrated and all impact values as obtained from the machine were corrected for the acceleration of the swinging detail of the fixture.

The values of shear reported were obtained in a shear-test fixture on the Amsler 20,000-lb testing machine, using the

[1] "Effect of Screw Threads on Fatigue," by S. M. Arnold, MECHANICAL ENGINEERING, vol. 65, 1943, p. 497.

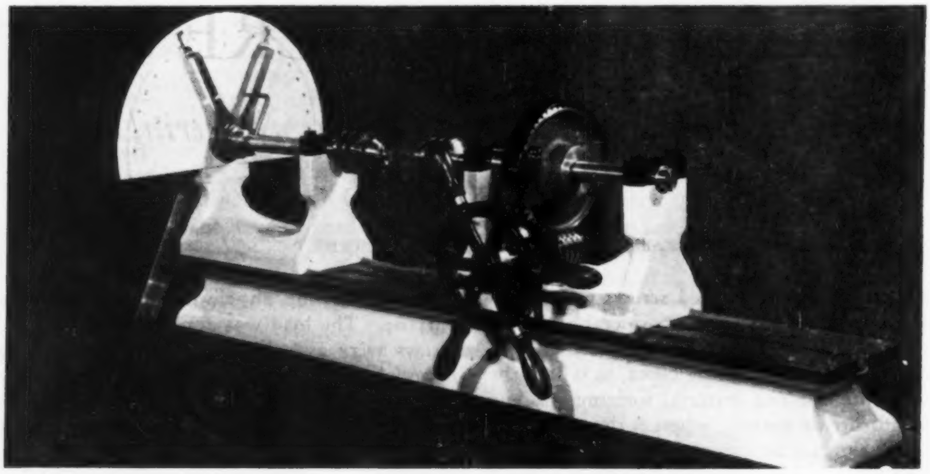

FIG. 1 TORSION-TEST MACHINE

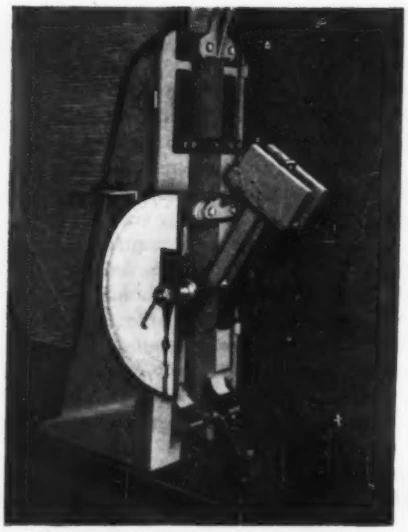

FIG. 2 IMPACT-TEST MACHINE

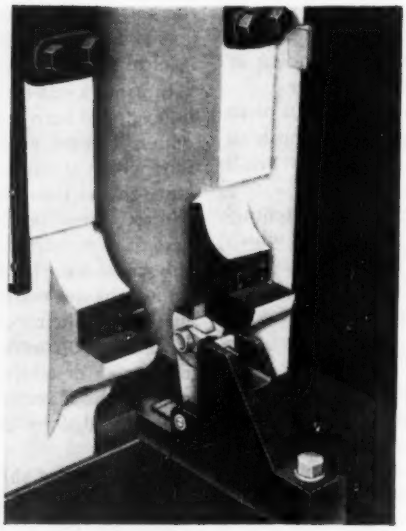

FIG. 3 CLOSE-UP SCREW-TEST FIXTURE MOUNTED IN IMPACT-TEST MACHINE

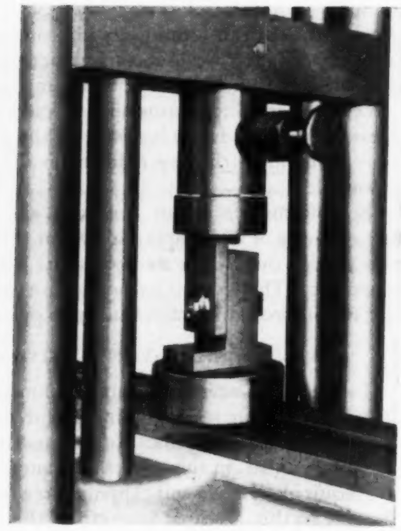

FIG. 4 SHEAR-TEST FIXTURE MOUNTED IN AMSLER TESTING MACHINE

2000-lb scale. The fixture consisted of two hardened-steel members held together with the screw under test, as shown in Fig. 4. The pressure was applied to the assembly perpendicular to the axis of the screw.

The values of impact shear were obtained in the 50-ft-lb impact testing machine by means of a special fixture shown in Fig. 5. The screw under test was inserted in a hardened-steel free-sliding block, and then into the hardened-steel fixture. The falling hammer hit the sliding block shearing off the screw under test.

The metallic materials tested with the self-tapping screws to obtain the values reported in the charts, Figs. 6 to 16, inclusive, were selected from those most commonly used in engineering designs and are as follows:

1 The steel was low-carbon sheet comparable to S.A.E. Specification 1010-1015.

2 The brass was high-brass sheet, half hard per A.S.T.M. Specification B-36, Alloy 8.

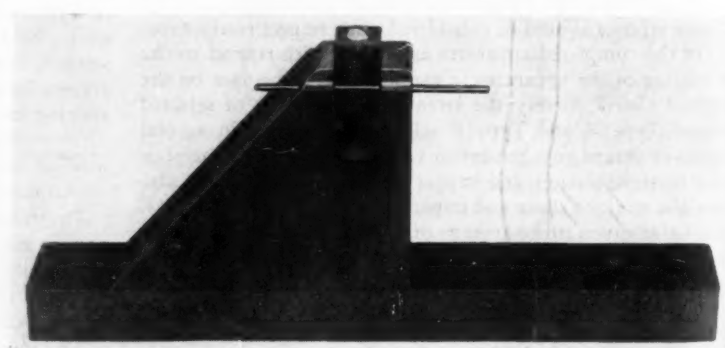

FIG. 5 IMPACT-SHEAR-TEST FIXTURE

3 The aluminum alloy was Alloy 17S-T strip.

4 The zinc-base die-casting material was in accordance with A.S.T.M. Specification B-86, Alloy 23.

5 The magnesium used was in accordance with A.S.T.M. Specification B-80, Alloy 4 heat-treated and aged.

In the case of the nonmetallic materials N.E.M.A. standard grade XX laminated phenol fiber sheet was used, as well as some materials which may be used as substitute for this material. They are as follows:

1 Compressed boards made from exploded softwood fibers, commonly known as "Tempered Presdwood."[2]

2 Compressed boards made from exploded hardwood fibers, commonly known as "Tempered Die Stock."[2]

3 Laminated lignin plastic sheet.

USE OF DATA

The charts, Figs. 6 to 16, inclusive, may be used in several ways. For example, it is required that a piece of apparatus weighing 1 lb be suspended by four screws from a sheet of aluminum. The apparatus must stand a shock load of 10 ft-lb. Reference to Fig. 8 indicates that almost any size screw with a thread engagement of $^1/_{16}$ in. will stand the tension load. However, under impact load, using a safety factor of 2, a 0.138-in. screw either Type Z or F with a thread engagement of 0.187 in. is indicated. Hence the use of four (0.138-in.) Types Z or F screws with a thread engagement of 0.187 in. will probably supply a satisfactory fastening for the apparatus.

In another case it may be desirable to know the amount of torque that can safely be applied to a 0.164-in. Type Z screw in $^1/_4$-in. phenol fiber. Reference to Fig. 11, will give this information.

In using these charts it will be well to remember that the values given are the averages of at least five determinations and in most cases more than five. Owing to this fact, an ample safety factor should be used in establishing loads or lengths of thread engagements for a particular screw. A study of the charts indicates that, in the softer material, longer thread engagements are required to develop the full strength of the screw.

No figures of fastening strengths for screws inserted parallel with the laminations in laminated insulating materials are given here. Tests made under these conditions show that the laminations are spread due to the action of the screw in forming or cutting a thread. The spread lamination gives a weak fastening and hence was not considered in this paper.

In using the information given in this paper cognizance should be taken of the following facts:

1 The threads formed by the Type F, Types 1, 2, and 9 screws are not in all cases interchangeable with standard screw threads in spite of the fact that the threads are cut to the specification of the national standard thread form. Those of one producer may cut a thread which will take a standard screw, whereas those of another make may cut a thread with slight dimensional variations which will not accept a standard screw.

2 Under tension loads, the screws of various producers of self-tapping screws do not all perform in the same way. The values shown on the charts represent the average strengths of screws from producer A. When screws from producers B and C were tested under tension in a thickness of steel required to break screws from producer A, the results were stripped thread on the screws rather than broken screws.

The values shown on the charts are the average values under conditions that obtained in our tests.

ACKNOWLEDGMENT

We wish to acknowledge the assistance given by the engineers of Parker Kalon Corp., Shakeproof, Inc., and other screw manufacturers in furnishing samples and other engineering information.

[2] Masonite Corporation, Chicago, Ill.

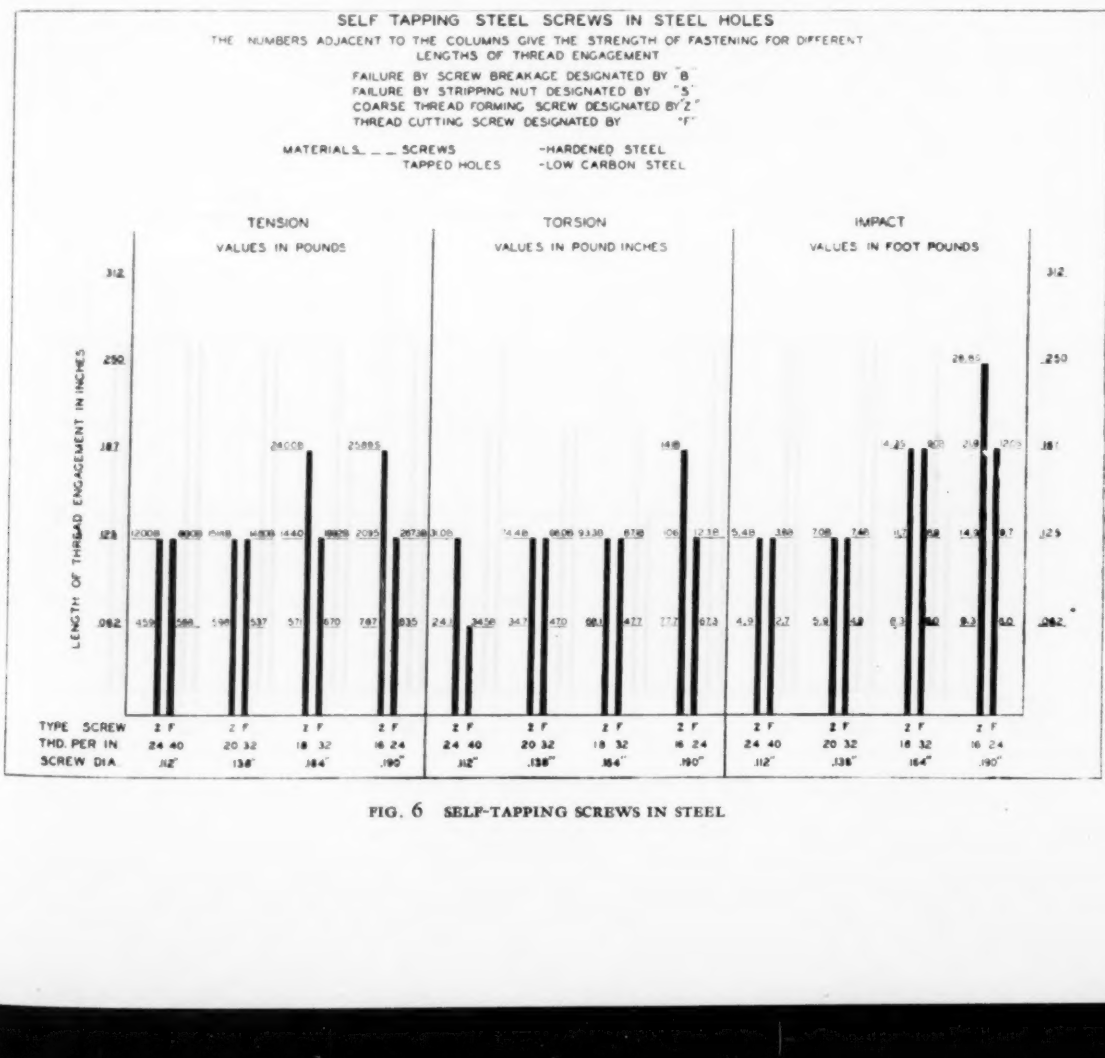

FIG. 6 SELF-TAPPING SCREWS IN STEEL

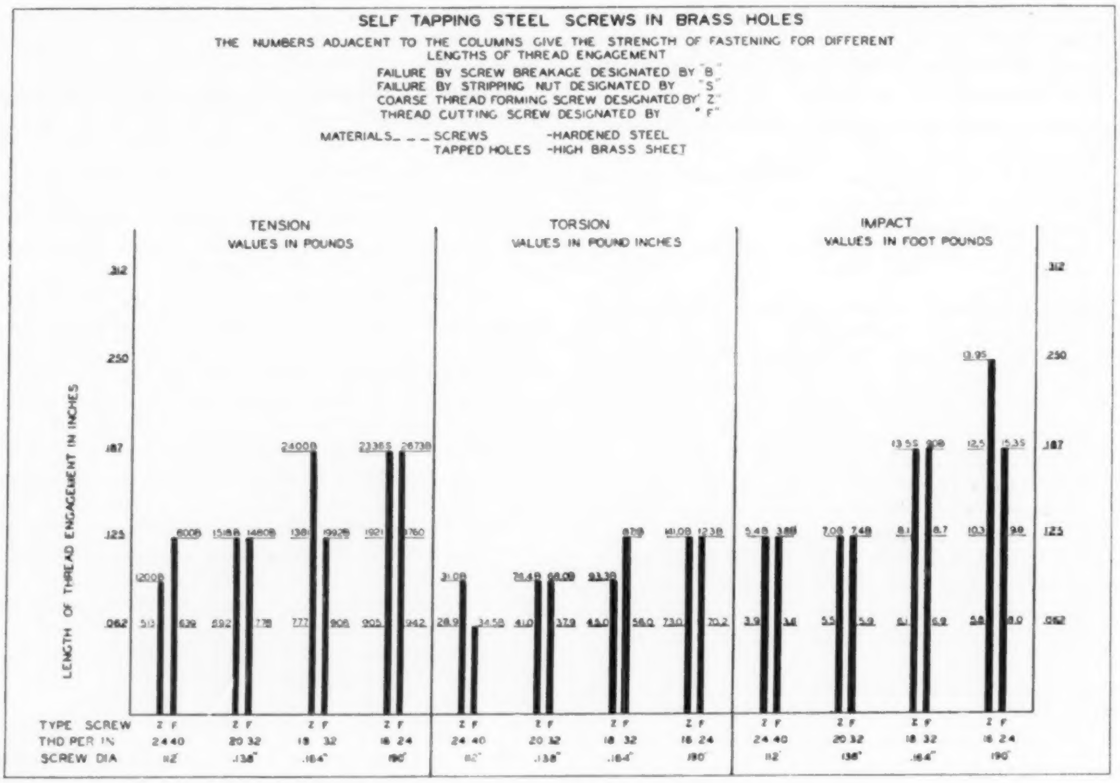

FIG. 7 SELF-TAPPING SCREWS IN BRASS

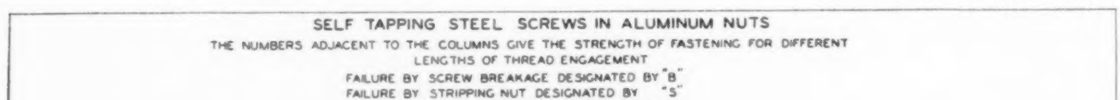

FIG. 8 SELF-TAPPING SCREWS IN ALUMINUM

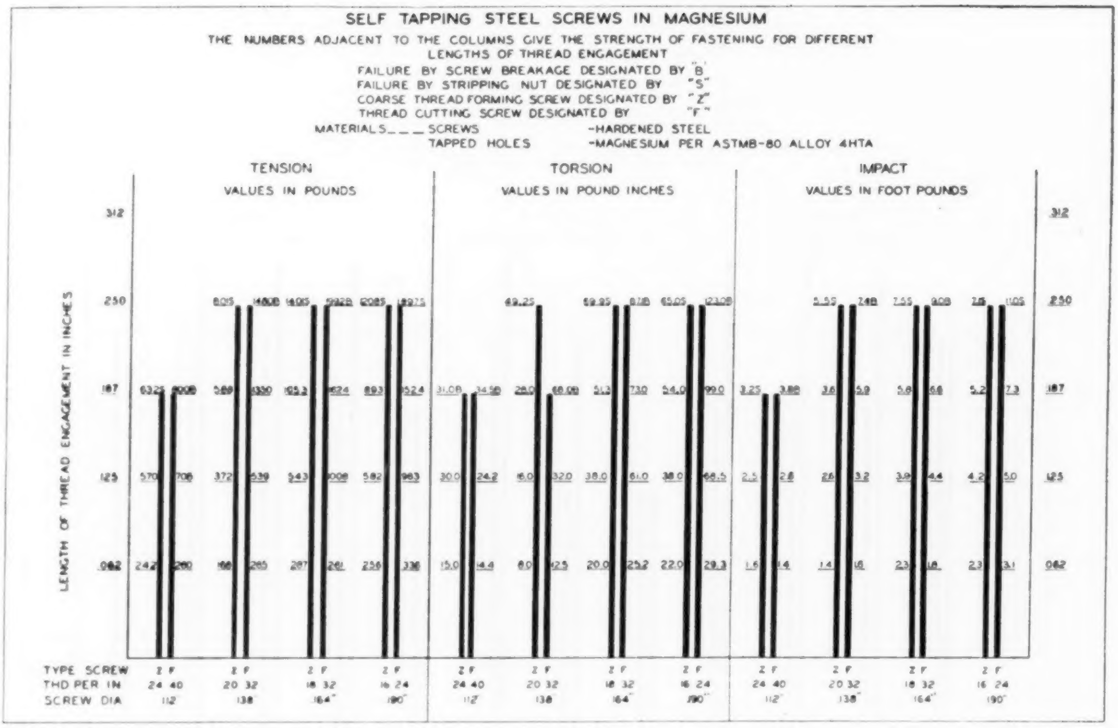

FIG. 9 SELF-TAPPING SCREWS IN MAGNESIUM

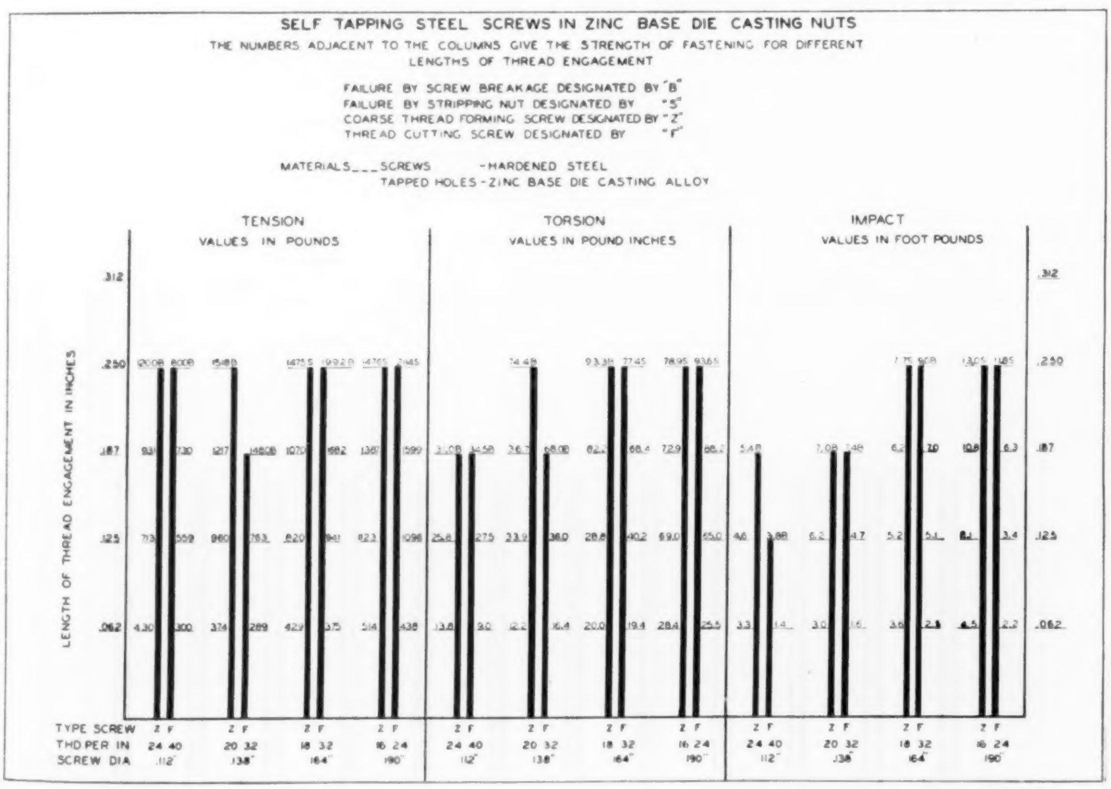

FIG. 10 SELF-TAPPING SCREWS IN ZINC-BASE DIE-CASTING MATERIAL PER A.S.T.M. SPECIFICATION B-86, ALLOY 23

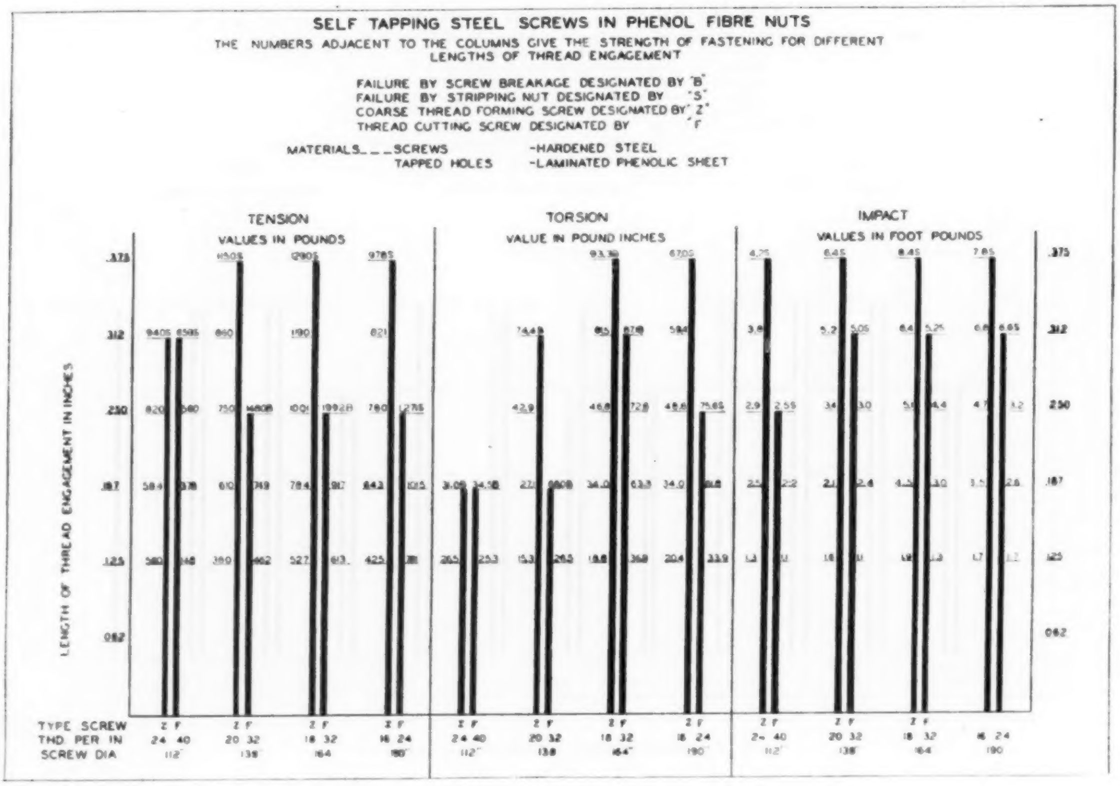

FIG. 11 SELF-TAPPING SCREWS IN LAMINATED PHENOLIC SHEET

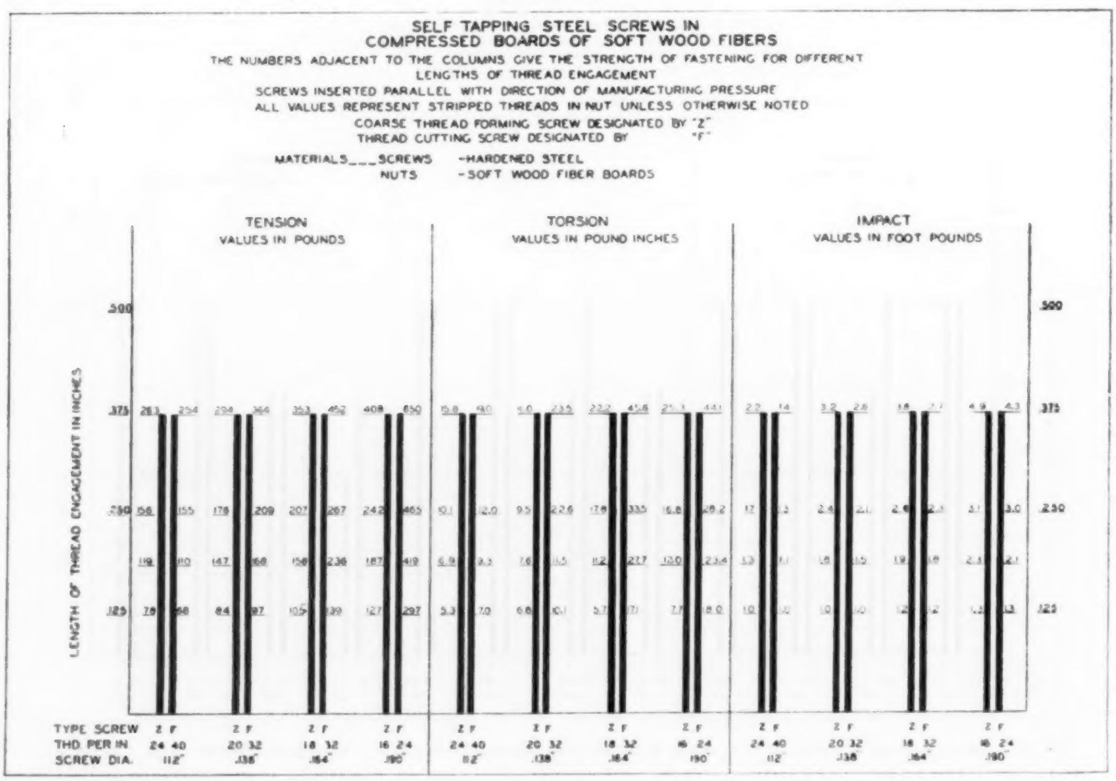

FIG. 12 SELF-TAPPING SCREWS IN COMPRESSED BOARDS MADE FROM EXPLODED SOFTWOOD FIBERS

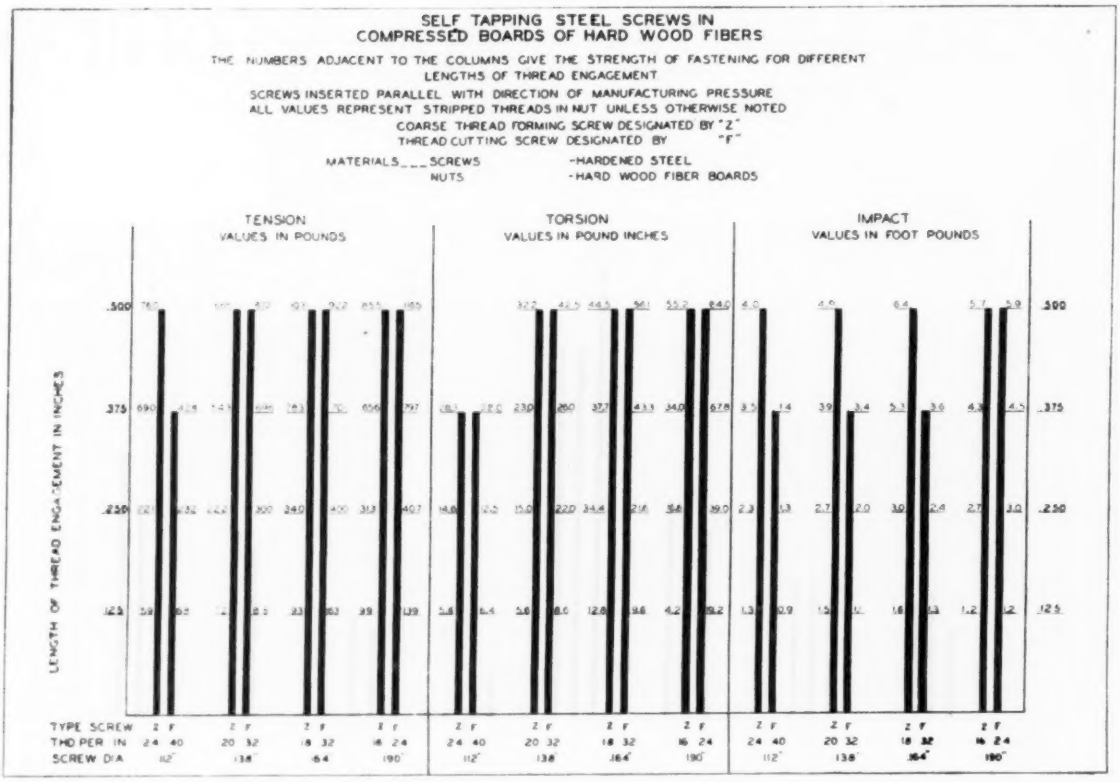

FIG. 13 SELF-TAPPING SCREWS IN COMPRESSED BOARDS MADE FROM EXPLODED HARDWOOD FIBERS

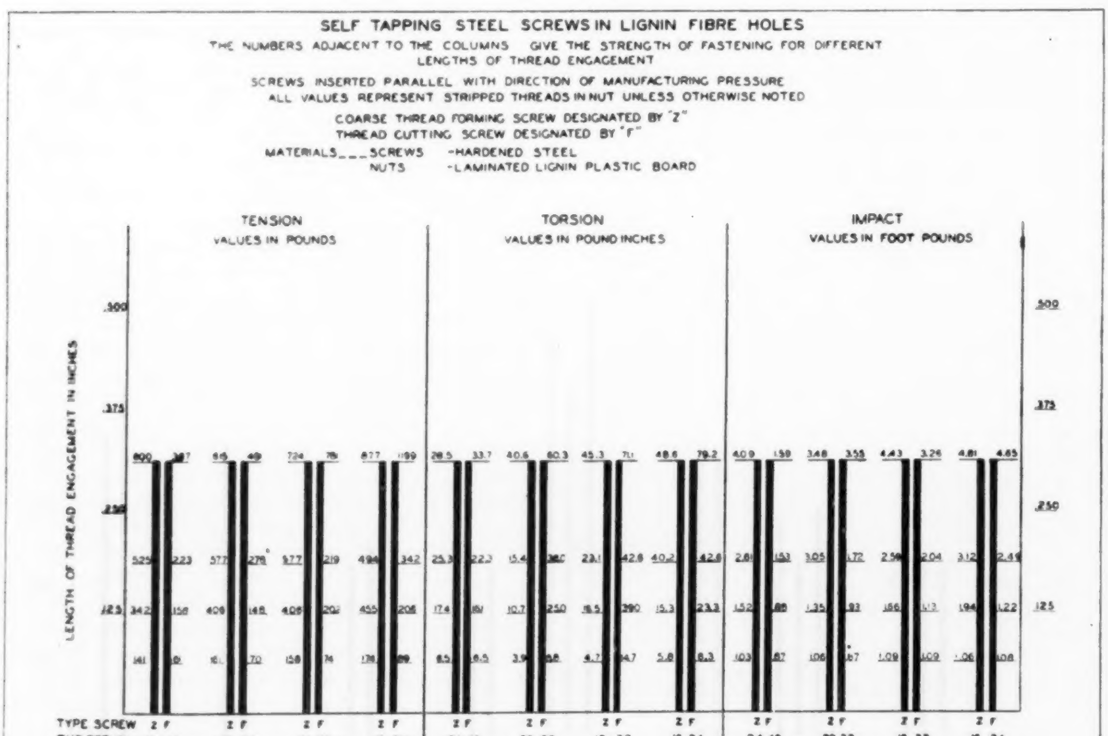

FIG. 14 SELF-TAPPING SCREWS IN LAMINATED LIGNIN PLASTIC BOARD

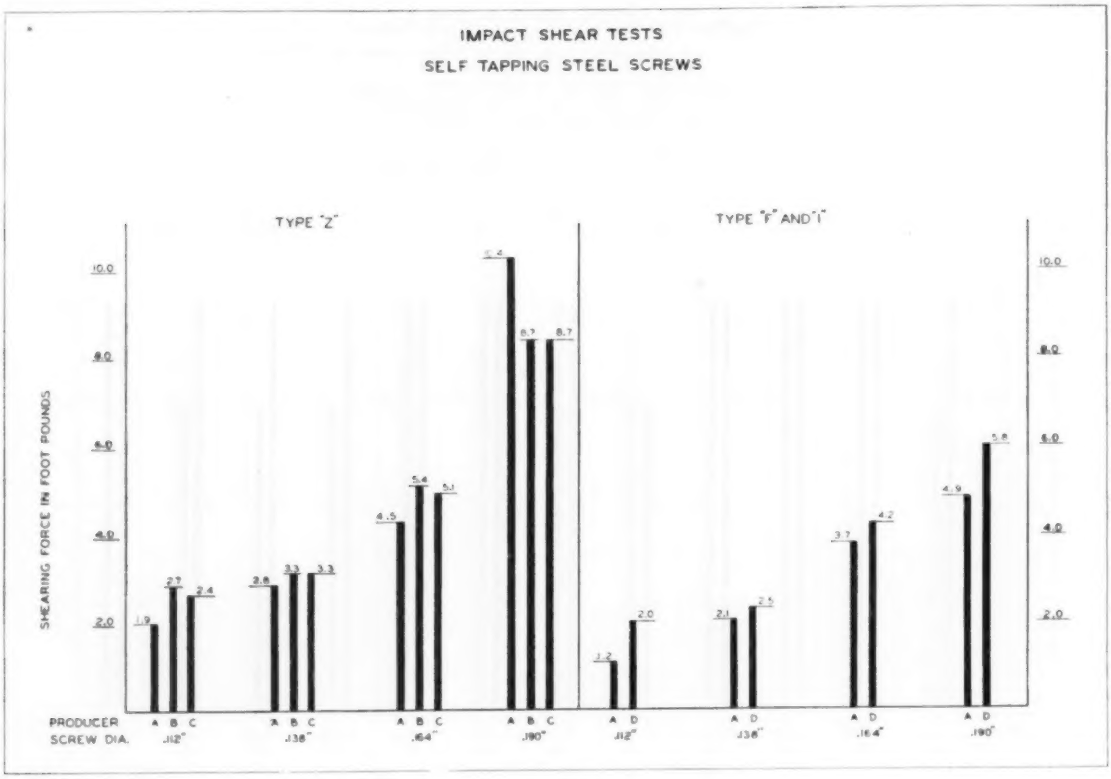

FIG. 15 IMPACT SHEAR TESTS ON SELF-TAPPING SCREWS

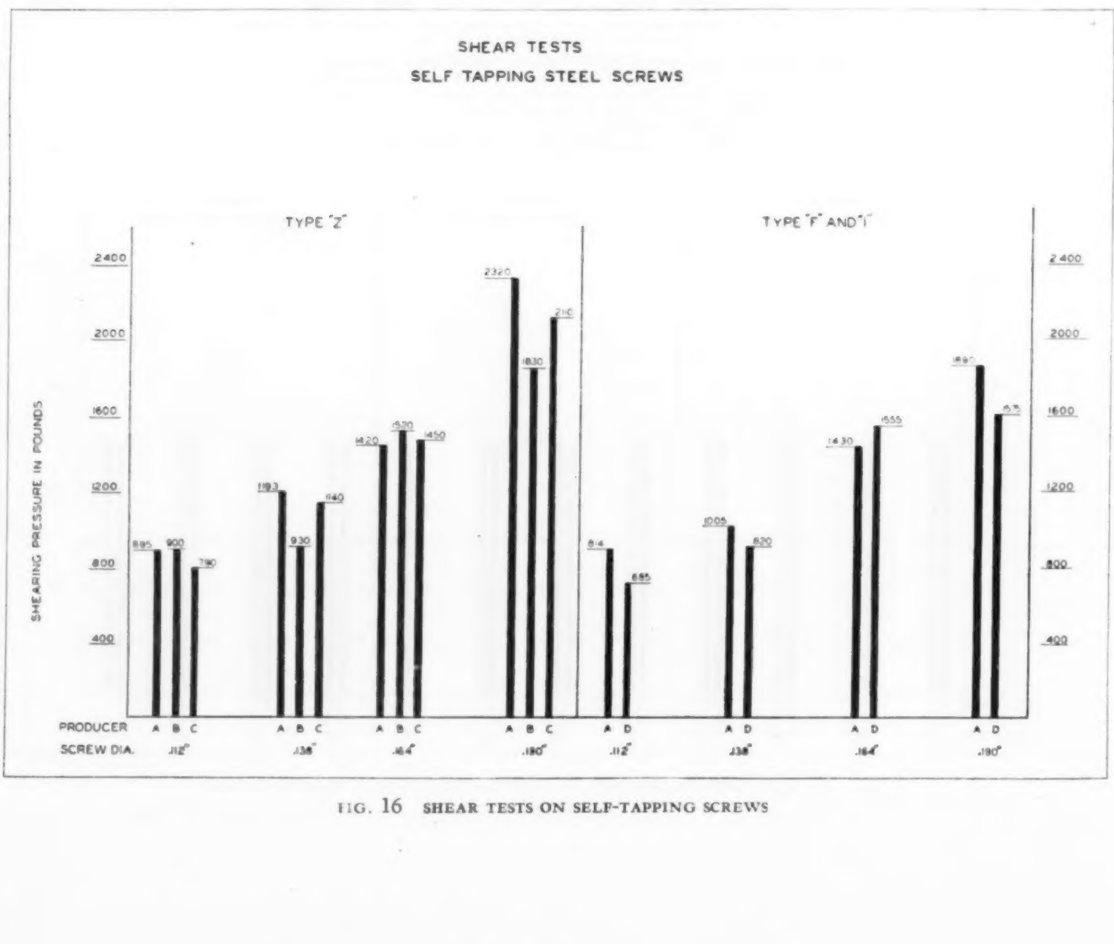

FIG. 16 SHEAR TESTS ON SELF-TAPPING SCREWS

CORROSION IS NO ACCIDENT

By MAJOR H. E. SMITH, JR.[1]

CHIEF PRODUCTION INSPECTION SUBDIVISION IV, AIR SERVICE AREA COMMAND, BIAK N.E.I

ALL metals are somewhat affected by the atmosphere. This effect, known as corrosion, is especially important in aircraft construction, maintenance, and inspection. Because corrosion reduces the strength and ductility of a metal unless controlled, even a small amount is unsafe on the relatively thin sections used in aircraft construction. Extensive studies have therefore been devoted to the prevention and protection of metals against corrosion. No attempt will be made here to explain and identify the various metals which have been developed that are corrosion-resistant in themselves, namely, Inconel, K-Monel, and Alclad.

It has been established that corrosion is caused by moisture in the air. Remove the moisture and dry metal will not corrode. It was believed at one time that the corrosion of aluminum was similar to ordinary decay; that once started it would progress until the entire surface of the sheet or part was similarly affected. This theory is easily disproved by a simple test, i.e., that of placing a corroded section of aluminum in a sealed container with the atmosphere completely dry. No further corrosive action will be noted since the cause of the corrosion has been removed. Therefore, when a piece of skin on an airplane is pitted, and examination reveals that the attack is only superficial, the area affected may be thoroughly cleaned and an approved protective coating applied that will eliminate any further attack.

CORROSIVE ACTION ON ALCLAD

In this study the areas where normal pitting and eating away were experienced were all on Alclad sheet. During heat-treatment of Alclad, the alloying elements from the core diffuse into the coating, forming what is known as the diffusion zone. As corrosion proceeds from the surface of the sheet inward, three zones of different solution potential are encountered, i.e., the pure-aluminum coating, the diffusion zone, and the core. The pure-aluminum coating protects the diffusion zone, and the diffusion zone protects the core. Looking down on a corroded sheet gives a craterlike impression. Such a condition indicates that the corrosion has proceeded only to the diffusion zone and that the Alclad principle is functioning in protecting the core. If the corrosion has not proceeded far enough to give this crater effect, the corrosion is superficial. If corrosion has not entered the diffusion zone, tests have indicated that the mechanical properties of the corroded section show no significant change in comparison with the uncorroded area. Corrosion, however superficial, is an indication that an undesirable condition exists. Timely and thorough inspection will detect corrosion in its initial stages when it can be stopped before becoming dangerous.

However, there is a second type of corrosion to which metals used in aircraft construction are subject. This type is not visible on the surface and consequently is very dangerous. It is called intergranular or intercrystalline corrosion, because it eats its way internally through the metal around the grain or crystal boundaries. This type of corrosion may be detected by cleaning the surface of the metal thoroughly and attempting to remove with a knife point the suspected corrosive area. If intercrystalline corrosion is present, the metal will offer very little resistance to the knife edge and may be removed in flakes or layers. The mechanical properties of alloys so attacked are normally entirely destroyed. This type of corrosion is seemingly limited to aluminum alloys containing copper, such as 17S and 24S. The resistance of these materials to this type of corrosion is greatly lowered by incorrect heat-treatment or by slow quenching. It is imperative that all quenching be done immediately in cold water to avoid intercrystalline corrosion. Protective coatings have very little influence on this type of corrosion.

CORROSION STUDY ON EIGHTY C-47 TYPE AIRCRAFT

The following study of corrosion was made on eighty C-47 type aircraft that were assigned to the reparable aircraft pool at Biak Air Depot, Biak Island, Netherlands East Indies. The flying time on these airplanes ranged from 1065 to 3426 hr; the average time being 2464 hr. Ninety-five per cent of the airplanes arrived in the Southwest Pacific Area with less than 100 hr total aircraft flying time. Both types of corrosion, normal eating away or pitting and intercrystalline, were encountered in varying degrees of intensity on all aircraft studied.

An attempt was made to correlate the amount and severeness of corrosion encountered with the number of flying hours on the airplane and/or the number of flying hours in this theater of operations. Also, a comparison was made of intensity of corrosion and number of calendar months in this area. No satisfactory results were obtained; aircraft with only 2000 hr were found to be more extensively corroded than those with 3000 hr.

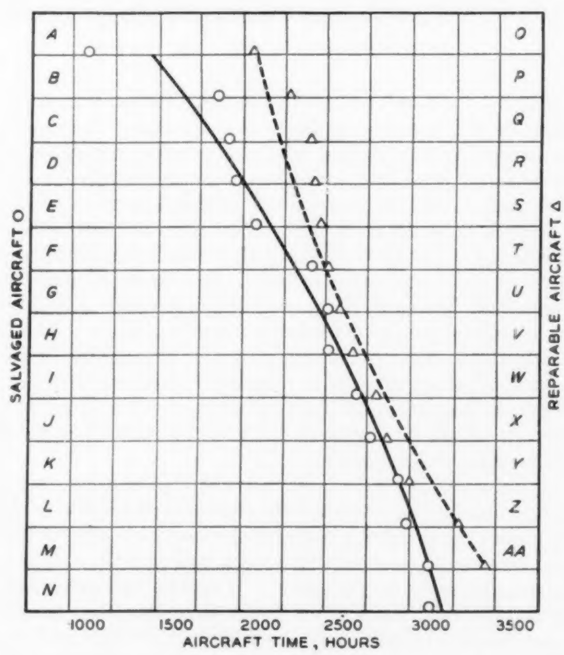

FIG. 1 AIRCRAFT TIME IN SOUTH PACIFIC AREA USING 14 AIRCRAFT WITH WORST CORROSIVE CONDITION AND 13 AIRCRAFT THAT WERE REPARABLE

[1] Junior Mem. A.S.M.E.

Contributed by the Metals Engineering Division for presentation at the Annual Meeting, New York, N. Y., December 2-6, 1946, of The American Society of Mechanical Engineers.

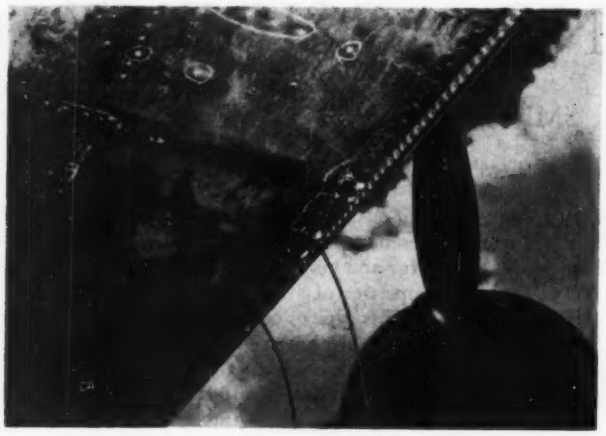

FIG. 2 AIRPLANE M: REAR LOWER WING-MOUNTING BRACKET ON LEFT-HAND INNER WING AT WING STATION 142

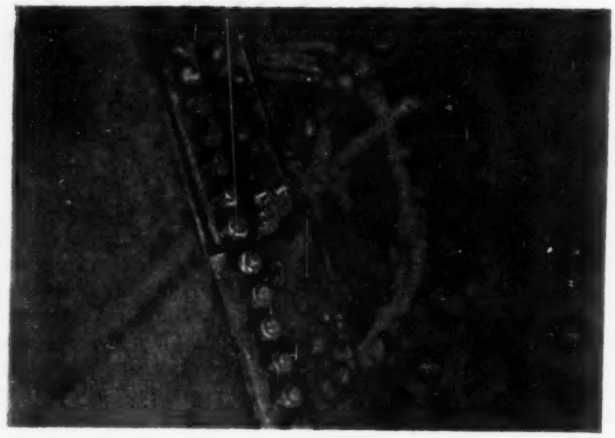

FIG. 3 AIRPLANE N: OUTBOARD WING REAR LOWER WING-MOUNTING ANGLE, FRONT EDGE; WING STATION 142

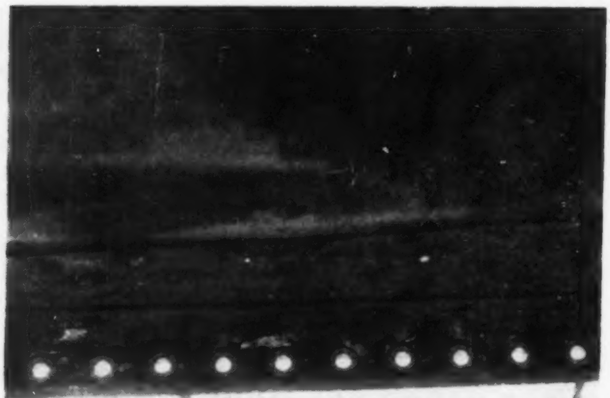

FIG. 4 AIRPLANE K: LOWER LEFT-HAND INBOARD REAR WING ATTACHING ANGLE; WING STATION 142

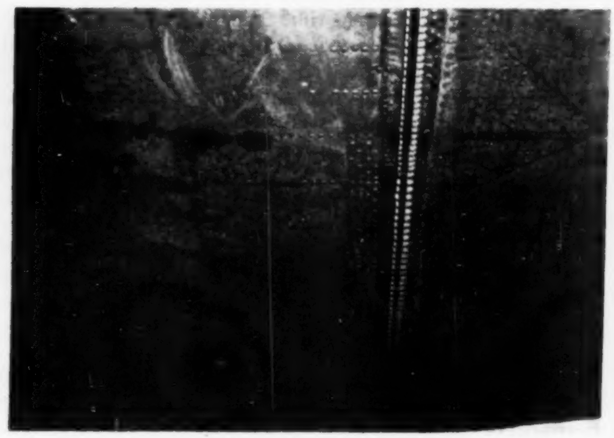

FIG. 5 AIRPLANE D: LEFT-HAND INNER WING, AFT OF STACK ON LEFT-HAND SIDE; WING STATIONS $109^3/_4$ TO 142

Similarly, the number of months in this area had no appreciable effect on the intensity of the corrosive action. The reason for an attempted comparison was the extreme humidity, night moisture, and rainfall, encountered in the Southwest Pacific, and further, since it is positively established that corrosion is caused by moisture in the air. There is no attempt to disprove this fact, but generally speaking, the amount of moisture present was not the contributing factor to the amount of corrosion encountered. The cause of the trouble was definitely determined to be a lack of proper maintenance and inspection. The small amount of flying time and the uniformity of corrosion evidenced, regardless of the amount of time exposed to the moisture condition of this area, plus the small amount of corrosion on a few aircraft where maintenance has been acceptable, give definite grounds for this statement.

Conclusions as reached are that although the extreme moisture content in the air caused the corrosion to develop as rapidly as it did, the primary reason for the corrosion getting its start and continuing its destructive work was entirely lack of maintenance by using organizations. If applicable instructions had been followed, there is no doubt that corrosion would not have been in evidence in the short number of hours and months flown. Inadequate maintenance caused the premature loss of approximately seventy C-47 aircraft that have been turned in to the Biak Air Depot during the last 6 months.

After a close inspection, 13 of the aircraft turned in were, it was considered, economical to repair, with an expenditure of approximately 2000 man-hours each. An estimated 40 per cent of this time was directly attributed to corrosion. The remainder of the aircraft were uneconomical to repair at this base and subsequently were salvaged. The damage caused by corrosion was of such extent that the facilities, both equipment and manpower, were not available for repair.

Fig. 1, representing 27 of the aircraft studied, definitely shows that the amount of time in this theater, exposed to these rigid climatic conditions, is not the determining factor as to severity of corrosion. In other words, one aircraft with 2000 aircraft-hours was so severely corroded that repair was not attempted while another aircraft with 3500 aircraft-hours that had been maintained to some extent had very little corrosion and was acceptable for repair.

LOCATION OF CORRODED AREAS

Corrosion as found on inspection of C-47 aircraft was localized in six general areas. These were: (1) Inner wing flaps between stations 142 and 73 on both right and left wings; (2) lower skin surface of inner wing aft of exhaust port to trailing edge between stations 142 and 109; (3) inside surfaces of inner wing from rear spar to trailing edge between stations 142 and 91; (4) landing gear; (5) lavatory compartment below flooring on bulkheads, longerons, skin, and stringers between stations 538

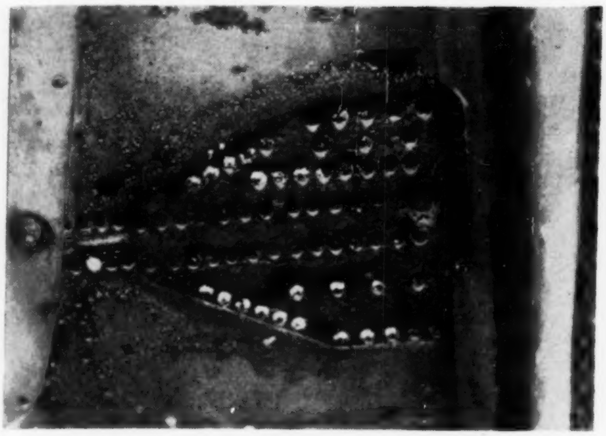

FIG. 6 AIRPLANE B: RIVET HEADS BAD, DOUBLER AND SKIN ON LEFT-HAND SIDE AFT OF EXHAUST OUTLET; WING STATIONS $126^7/_{16}$ TO 142

FIG. 7 AIRPLANE F: RIVET HEADS OFF FROM LEFT-HAND SIDE OF INBOARD WING AFT OF EXHAUST OUTLET; WING STATIONS $126^7/_{16}$ TO 142

FIG. 8 AIRPLANE J: RIVET HEADS MISSING ON LEFT-HAND SIDE; WING STATIONS $162^7/_{16}$ TO 142

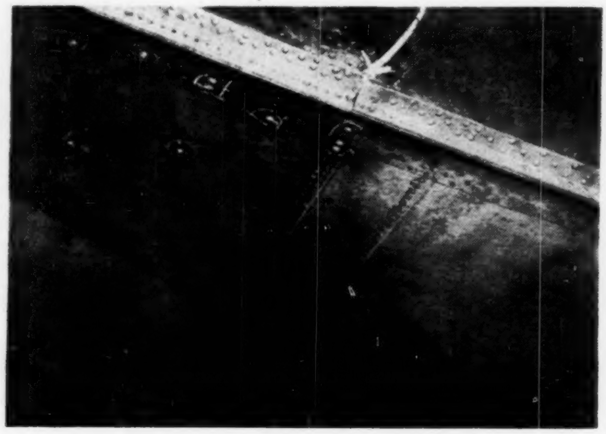

FIG. 9 AIRPLANE J: CORRODED WING-MOUNTING ANGLE JOINT ON CENTER LOWER OUTBOARD ANGLE LEFT-HAND SIDE; WING STATION 142

and 583; (6) battery compartment and skin fuselage aft of station 117.

When fairing was removed from wing attaching angles, severe intercrystalline corrosion was found. As shown in Figs. 2 and 4, the left-hand inboard attaching angles were corroded at angle butt joints, and succeeding areas of corrosion were found along the entire length of the angle with severity increasing toward the trailing edge of the wing. In general, the intercrystalline corrosion found was on the inboard angle; however, 60 per cent of the wings inspected had the outboard wing attaching angle corroded as shown in Fig. 3. Of 13 aircraft repaired, 16 outer wing panels were replaced because of this type of intercrystalline corrosion.

Furthermore, one of the principal reasons for declaring the majority of the C-47's nonreparable was this severe corrosion of the inboard wing angle. Moisture collects readily beneath the fairing covering these angles and is slow to evaporate, consequently the fairing should be removed and the angles and wing bolts checked every 25 hours for corrosion. If this inspection and corrective maintenance had been followed, none of these aircraft would have been damaged.

This corrosive action was far enough advanced that upon removal of wing bolts some were found to be undersize and partly eaten away. Fig. 5 gives a general picture of the normal surface corrosion discovered. Close-up views, Figs. 6 and 7, of the inner-wing doubler located aft of the exhaust stack shows the extent and severity of corrosion experienced in that location. The heads of many rivets were easily snapped off with the thumbnail and nearly all rivets were corroded to some extent. The corrosive action on the rivets was intercrystalline, already in an advanced state. Figs. 8 and 9 show a typical inner wing surface and the extent of defective rivets. The absence of rivet heads and the reason for this defect is easily detected. It was noted during the inspection of the 80 aircraft that the extremely bad areas of the inner wing were all on the left-hand side. Only one aircraft had bad rivets on the right-hand inner wing. This may be explained by remembering the direction of rotation of the propellers. Simple tests showed that the temperature of the left inner wing was higher than the temperature of the right inner wing on C-47 aircraft. Almost all illustrations here are of the left inner wing surface, lower side.

Fig. 10 shows inceptive corrosion beneath fairing over the wing angles. The exposed areas of the angle were pitted with intercrystalline corrosion. In the area of the attaching angles and inner wing surfaces both normal and intercrystalline corrosion were observed.

Figs. 11, 12, and 13 show the amount and severity of corro-

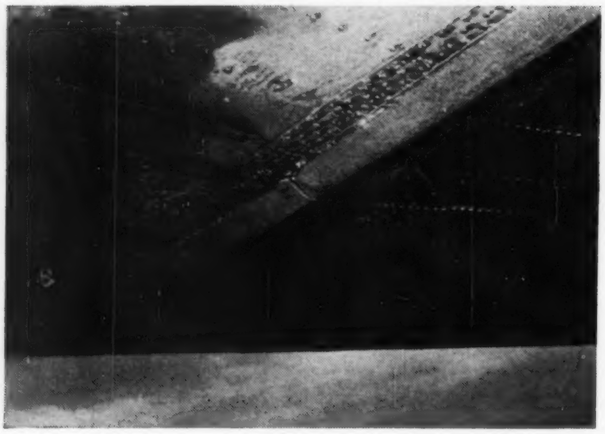

FIG. 10 AIRPLANE B: CORRODED LOWER RIGHT-HAND WING-MOUNTING ANGLE FAIRING STRIP, SKIN, RIVETS, AND BOLTS; WING STATION 142

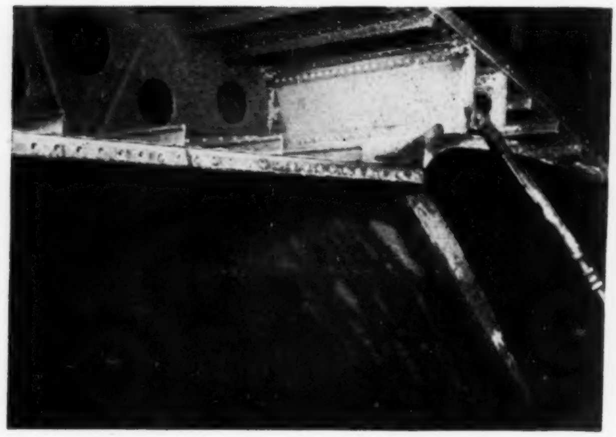

FIG. 11 AIRPLANE M: INSIDE OF TRAILING EDGE OF LEFT-HAND INNER WING; STRINGERS AND RIBS CORRODED; WING STATIONS $126^7/_{16}$ to 142

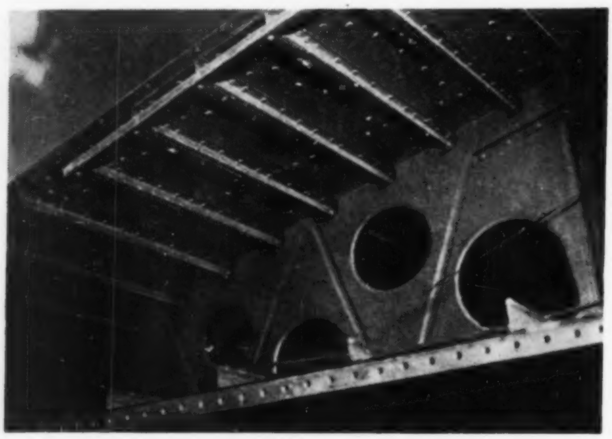

FIG. 12 AIRPLANE A: RIGHT-HAND INNER-WING INSIDE TRAILING EDGE; WING STATIONS $109^3/_4$ to 142

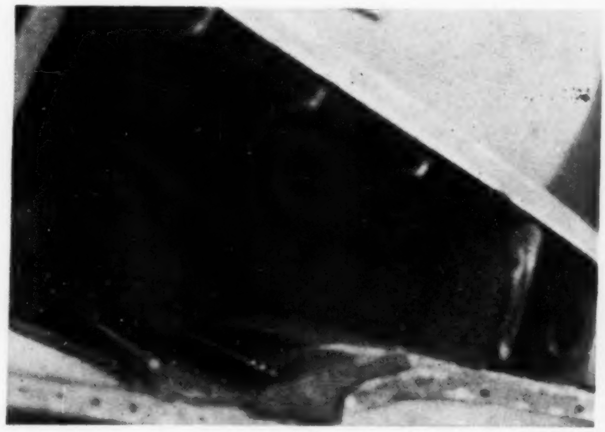

FIG. 13 AIRPLANE K: INSIDE AFT LATERAL FILLER WEB OF LEFT-HAND WING; WING STATIONS $126^7/_{16}$ to 142

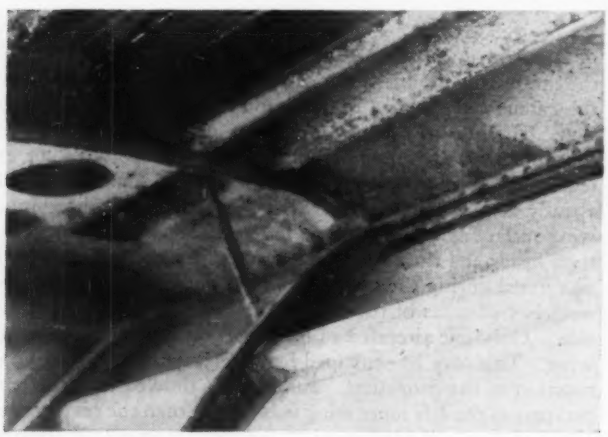

FIG. 14 AIRPLANE M: CORRODED STRINGERS, RIB AND SKIN IN RIGHT-HAND WING-FLAP WELL; WING STATIONS $109^3/_4$ to 142

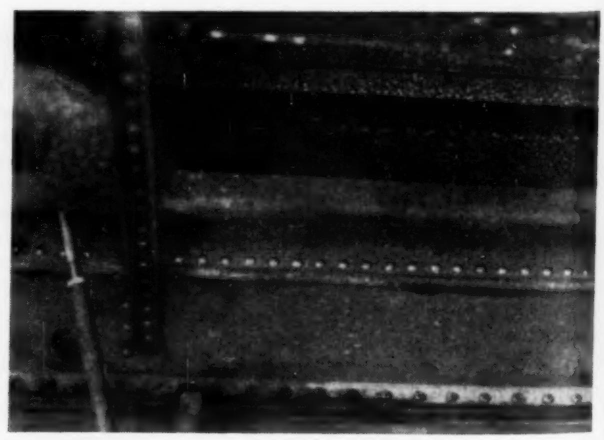

FIG. 15 AIRPLANE E: FLAP-WELL STRUCTURAL MEMBERS; WING STATIONS $109^3/_4$ to 142

sion normally found on inside surfaces of the inner wing from rear spar to trailing edge. Most of the corrosion here is ordinary surface corrosion; however, intercrystalline corrosion was found at the junction of the filler web and rib at station 126. Fig. 13 shows the holes in the rib that have been caused by this severe corrosive action. Corrosion in varying degrees of intensity was found in all aircraft inspected at this junction and succeeding junctions up to station 91. This defect was found on

FIG. 16 AIRPLANE H: WING-FLAP WELL AND FLAP STRUCTURE, RIGHT-HAND SIDE; WING STATIONS $109^3/_4$ TO 142

FIG. 17 AIRPLANE L: RIGHT-HAND TRAILING-EDGE RIBS, STRINGERS, SKIN INSIDE FLAP WELL; WING STATIONS $126^7/_{16}$ TO 142

FIG. 18 AIRPLANE I: BULKHEAD AND BEAMS IN LAVATORY COMPARTMENT; FUSELAGE STATIONS 538 TO 583

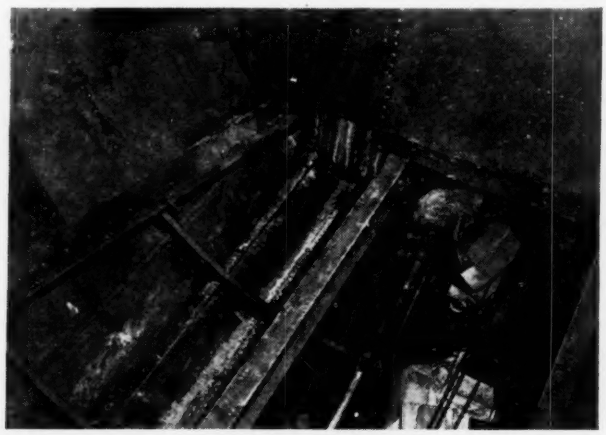

FIG 19 AIRPLANE D: BULKHEAD AND STRINGERS IN LAVATORY COMPARTMENT; FUSELAGE STATIONS 538 TO 583

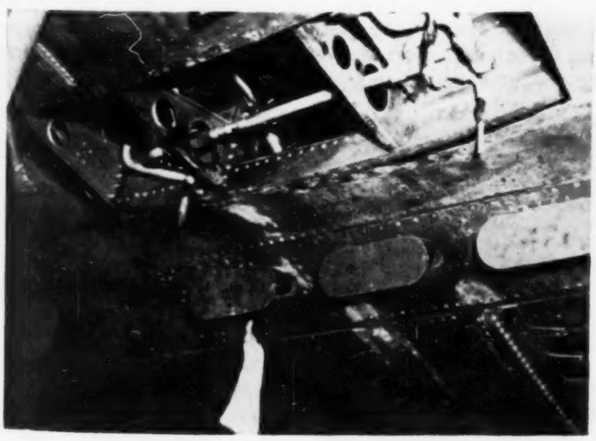

FIG. 20 AIRPLANE L: LOWER CENTER OF FUSELAGE AFT OF BATTERIES; AFT OF FUSELAGE STATION 192.5

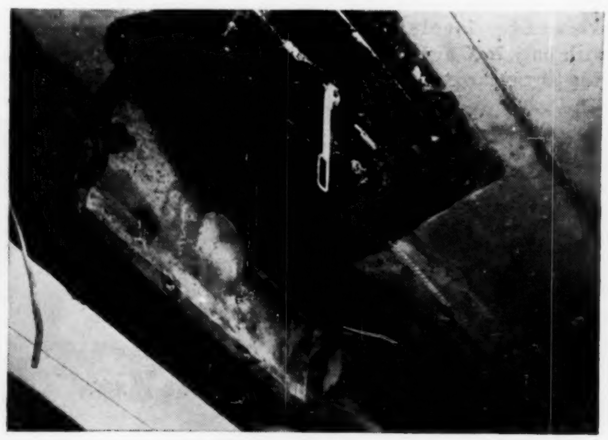

FIG. 21 AIRPLANE L: RUSTED LEFT-HAND BATTERY WELL; AFT OF FUSELAGE STATION 117.375

both right and left inner wings. Replacement is the recommended corrective action, and in this instance constitutes major repair. White deposits of corrosion surround most of the rivets in Fig. 12, and intercrystalline decay is seen on the duralumin extrusions.

Severe surface and intercrystalline corrosion was encountered in the wing-flap wells and flap structure on both right and left inner wings from station 142 to station 73. Figs. 14 and 15 show the extreme pitting and flaking of surface corrosion. Intercrystalline corrosion is evidenced on stringers where the

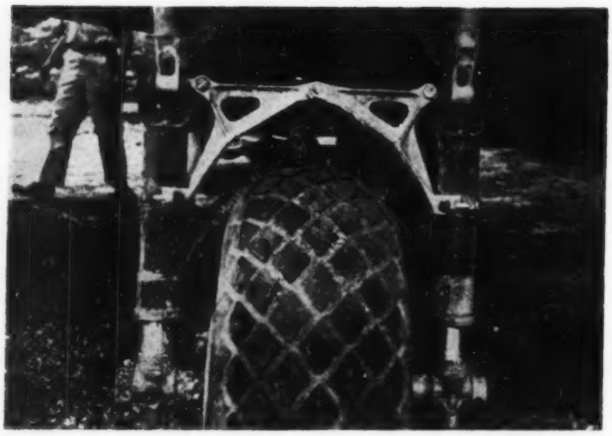

FIG. 22 AIRPLANE G: RUSTED MAIN LANDING GEAR

upper skin attaches. In Fig. 16 the intercrystalline decay of the extruded stringers is clearly shown. The stringers were pierced easily on inspection and the surrounding area is similarly affected. Many such examples were found. In some instances normal pressure of the hand would dislocate the extrusions between webs. Fig. 17 is a close-up of the junction of stringers and web at station 126, clearly showing how the metal is completely eaten away and destroyed. Moisture tends to collect in the flap wells and ordinarily dissipates slowly, necessitating close and continued inspection of these vital areas.

LACK OF ADEQUATE MAINTENANCE CAUSE OF TROUBLE

However, as shown by the illustrations and experienced on all the aircraft examined, it is evident that even the minimum maintenance was not performed. In some aircraft the flap wells had been coated with zinc-chromate primer over corrosion with no attempt to clean prior to painting, and the resultant destruction continued without letup. The type of repair necessitated by this damage is costly and difficult to perform under the existing conditions.

Severe intercrystalline decay was found under the floor of the lavatory compartment on bulkheads, longerons, stringers, and skin surface. Fig. 18 shows the extent of damage on an airplane with only 2600 aircraft-hours. It is common knowledge that this particular portion of the aircraft should be inspected and cleaned regularly due to the destructive effects of relief-tube-spray acid. If this had been done the loss of the aircraft would have been avoided. Fig. 19 shows similar decay on an aircraft with 1950 aircraft-hours.

In Figs. 20 and 21 the effects of battery acid are illustrated. The areas shown are subject to the effect of the acid. Proper cleaning and painting as needed will neutralize this unsatisfactory condition. The defective areas as shown here were experienced on every airplane inspected; however, on the majority it was observed that attempts had been made from time to time to perform some maintenance.

The last general area where corrosion was found is the landing gear. Figs. 22 and 23 show typical rusted struts as found on a large percentage of the aircraft. Generally speaking, there had been more effort given to maintenance of the landing gear than any of the other major assemblies. These illustrations are self-explanatory.

CONCLUSION

The inspection, detection, and prevention of corrosion are thoroughly discussed and explained, and corrective procedures outlined in practically every manual on aircraft maintenance, and in applicable AAF Technical Orders. In aircraft construction, metals have been developed and used that are highly resistant to corrosion in themselves. Chemical and electrolytic processes such as anodizing have been developed to further aid in controlling the spread of corrosion on aircraft. Special cleaning materials and processes have been devised. Corrosion-preventive paints are available for use on highly susceptible areas. In short, mechanical and scientific aids have been exploited thoroughly in the fight against corrosion; but regardless of these factors, unless proper inspection and maintenance are performed and completed, corrosion will set in and destroy. Airplanes must be kept as meticulously clean as the type of operations being performed permits. In the field the problem of corrosion and its prevention can well be controlled by "keeping the airplane clean."

This paper is not an attempt to condemn the using organizations, all of which have successfully completed a mission that was of such material benefit in the victory over Japan. However, an effort has been made to show the prime importance of inspection and cleanliness in the constant fight against destructive corrosion. It cannot be overemphasized that in the field, or at the depot and overhaul shops, cleanliness and corrosion prevention go hand in hand.

FIG. 23 AIRPLANE N: RUSTED MAIN-GEAR STRUTS

Some Consideration in Designing Parts for POWDER METALLURGY

By IRVING J. DONAHUE

PRESMET CORPORATION, WORCESTER, MASS.

POWDER metallurgy is the technique by which metals or alloys are produced in the finely divided state or powder form, subsequently being formed into finished products by welding together the individual particles of metal powder. Interlocking of the irregularly shaped powder-metal particles is accomplished by pressing in dies that have the shape of the part to be produced. Forming the part to its required shape and density is accomplished by using mechanical or hydraulic presses. It is then heated in an atmosphere-controlled furnace at temperatures below the melting point of one or more of the constituents. Later, if necessary, the part is coined or sized and then heat-treated to a required hardness.

With the end of the war, it quickly became known through the literature how vital the process of powder metallurgy had been to the war effort by saving time and material in the manufacture of many necessary products. The powder-metallurgy process eliminates waste and expensive machining to an extent that would be impossible by any other method. With the knowledge of the existence and value of such a process, many engineers and designers are asking themselves if their concerns have parts that would be adaptable to powder metallurgy. In many cases the answer would be "yes," requiring only minor changes in design.

LIMITATIONS AND ADVANTAGES OF PROCESS

It must be understood by engineers and designers that powder metallurgy has some limitations. Paramount among these is strength which is generally less in parts produced by this process than when the same parts are produced by the cast or forging method. Largely because of porosity and not as a result of a difference in microhardness, hardness figures seem low in comparison with denser materials. There is a definite limitation to the size and shape of some parts made, owing to the requirement of large presses to obtain the desired compacting pressures, thus resulting in expensive tool and press costs.

The high purity of the metal content of the finished part is one of the advantages of the powder-metallurgy process, thus reducing or eliminating the impurities that are found in metals made by the conventional methods. Purity is controlled by the mixing of selected powders and can be further enhanced at the time of sintering by the removal of oxides through the reducing nature of the atmospheres applied.

The composition of the part produced can be accurately controlled through the use of pure metal powders with little or no change in the composition during the pressing and sintering. Parts containing alloy compositions can be consistently reproduced. Refractory metals such as sintered carbides, tantalum, and tungsten, not possible to fabricate by the conventional methods due to their hardness and brittleness, can be made by the powder-metallurgy process. A wide range of physical properties can be obtained for a particular application, such as density, porosity, and grain size. In small magnets, structures developed may have better mechanical properties than the same material in cast form. The limitation of waste is associated with parts manufactured by powder metallurgy as there is little or no scrap.

Dimensional tolerances on small and medium-sized parts can be held to ± 0.001 in., which is as accurate as parts can be made by the conventional machine operations, such as drilling, milling, planing, and splining keyways. Powdered-metal parts can be laminated with more intricate binding than would be possible by the conventional method of attaching one metal to another. A good example is the combining of plastic materials and metal powders, as is done in magnets. Machined precision parts can be supplanted with powder-metallurgy parts with greater economy and accuracy, thus relieving a shortage of skilled mechanics or machines for parts that require expensive equipment. With the present delay in obtaining this new equipment, powder metallurgy is really the logical answer.

One of the fields of design for powder metallurgy includes structural and functional parts, in which the designer is interested in the shapes obtained. Many intricate shapes requiring costly secondary operations, if produced by the conventional methods, can be produced rapidly and satisfactorily by powder metallurgy at a lower cost, because they adhere to certain fundamental rules of design. On the other hand, much simpler shapes cannot be produced economically by powder metallurgy because they depart from these fundamental rules. Inasmuch as the pressing of the part to obtain the desired density is largely determined by the design of the part and the designer's understanding of the limitations of the pressing process, he can design parts accordingly and take full advantage of what powder metallurgy has to offer.

PRESSING OPERATIONS

Parts made by the powder-metallurgy process are pressed in a die that has the desired shape. The punches that apply the pressure to the powder in the die operate in a straight line with an upward and downward motion. The lower punch moves downward to the fill position, then rises to a predetermined height, raising the powder to the compression point. At the same time, the upper punch moves downward into the die to its predetermined depth, where both punches compress the powder to the desired density and shape. The lower punch then remains stationary while the upper punch moves upward and out of the die to a clearance height, followed by the lower punch rising to the top of the die, ejecting the part to the table level where it is removed by a sweep, which at the same time fills the die with powder and withdraws. The punches again start moving to complete another cycle. With these operations in mind, the designer must design the tools so that the finished part will have its required shape and density and be ejected from the die without rupturing.

Concentricity must be considered carefully and reasonable limits provided. This is necessary because the part in most cases is formed with tools that have radial fits within each other, and clearance must be provided so that they will not bind

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or score. If the clearance is too great, a build-up of powder along the die wall will result, causing eccentricity as high as 0.003 to 0.005 in. This may be avoided by not having a larger clearance than is necessary.

The length tolerance should be somewhat liberal in comparison with that necessary in conventional methods of finish, if extra cost of machining the part is to be avoided. As the length of most parts made by powder metallurgy is governed by the fill, done either by hand or mechanically, and regulated by the depth of fill and compressibility of the powder, each part to be designed must be considered individually with the length tolerances on short pieces from ±0.002 to ±0.005 in., while longer pieces will require ±0.010 in. or more.

When parts are designed with radial projections and recessions, as shown in Fig. 1, great care must be taken to avoid

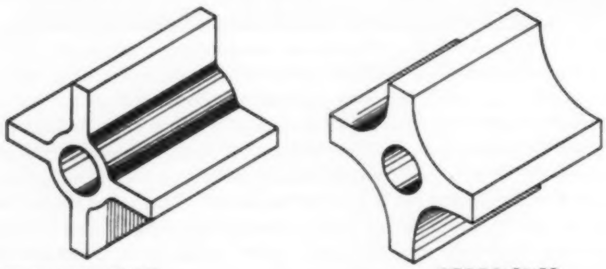

FIG. 1 ORIGINAL PART AND REDESIGNED PART FOR POWDER METALLURGY

deep and narrow splines which make it difficult to obtain complete powder fill, because the powder at the time of filling may bridge across the narrow splines, resulting in a pressed part, with less density and size than is required. The projections will also be weak and porous in structure, while tools made to produce parts with this poor design will rupture when pressure is applied. When parts are designed with these narrow projections, difficulties arise in ejecting the part from the die owing to the increased surface area.

DESIGN CONSIDERATIONS

Any abrupt change in cross section on the area in the axial direction is not so much the difficulty in pressing to obtain tolerances, as is the expansion or contraction of the part during sintering. This is due to the thin and thick wall sections which will not expand or contract uniformly as would more uniform designs. This change in cross section will cause the part, where the hole is round and the outside not a true diameter, to change in size after sintering, making it difficult to meet the customer's specifications when the tolerances are close.

Bushings. When parts such as bushings are made, as shown in Fig. 2, the wall thickness, that is, the distance between the outside diameter and the hole, is perhaps one of the designer's most important considerations. It is therefore necessary that a relation between length and diameter be considered. If parts with considerable length and thin walls are pressed, they may not have the desired density due to the powder not reaching the required die fill, i.e., the powder bridging across the narrow opening between the die wall and core rod. The punches will also be extremely weak due to the slenderness of their walls.

Thin Parts. When flat and thin parts requiring high density are pressed, great care must be taken to make sure that the section is not too thin, otherwise the punches may rupture when pressure is applied because of the lack of cushioning effect of the powder. Although sections as thin as 0.015 in. and 0.020 in. have been pressed, in most cases these sizes are obtained by applying a pressure that will give a medium density, sintered, and then coined to the desired density. It is recommended that flat sections of not less than 0.032 in. be pressed.

Shaped Holes. Parts that have shaped holes, keyways, or taper holes, can be made by the powder-metallurgy process by making use of a core rod. When the requirement is for parts having shaped holes, e.g., square, hexagon, half-round, or almost any other shape, the core rod can be shaped to the required design with the corresponding shape in the inside of both the upper and lower punches, so that when the powder is pressed and the part ejected from the die it will have the desired form. When keyways are required, a key is inserted into the core rod with corresponding key splines in both the upper and lower punches, thus helping to shape the keyway when the part is pressed.

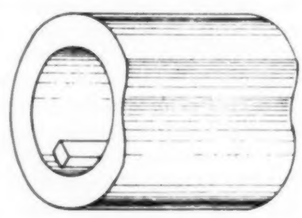

FIG. 2 BUSHING DESIGN

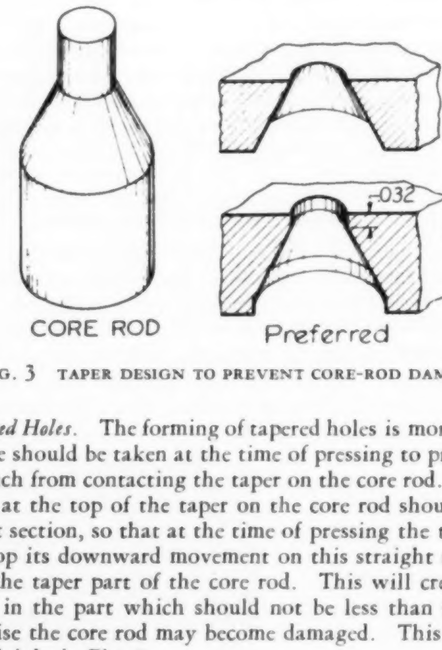

FIG. 3 TAPER DESIGN TO PREVENT CORE-ROD DAMAGE

Tapered Holes. The forming of tapered holes is more difficult and care should be taken at the time of pressing to prevent the top punch from contacting the taper on the core rod. A short section at the top of the taper on the core rod should have a straight section, so that at the time of pressing the top punch will stop its downward movement on this straight section or above the taper part of the core rod. This will create a flat section in the part which should not be less than 0.032 in., otherwise the core rod may become damaged. This is shown quite plainly in Fig. 3.

Flanged Parts. When making parts that have flanges with a body up to 1 in. diam, the flange diameter should not be more than $1^1/_2$ times the outside diameter of the part. If parts require flanges greater than $1^1/_2$ times the outside diameter, a more complicated die-and-punch arrangement must be used to help eject the part from the die, due to the overhang from the main body of the part and the friction on the die wall, which may cause the flange to crack or break. The outside diameter of the part should also have a taper of at least 0.008 in. in each inch of thickness of flange in order to help eject the part from the die. The radius on the inside corner where the flange unites with the body should be at least 0.010 in. This radius will help to strengthen the part and help to eliminate cracking or

breaking of the flange at the time of pressing, as shown in Fig. 4.

Bevels. Parts should not have too large a bevel or radius on their edges, because the bevel or radius on the punch will have a feather edge which may have a tendency to produce a burr at the time of pressing. Also, the life of the punches will be short unless great care is taken in the proper choice of tool steels and the subsequent heat-treatment to the correct hardness and toughness, so that they will withstand the pressures at the time of pressing without the feather edge breaking off or turning over. This is shown in Fig. 5.

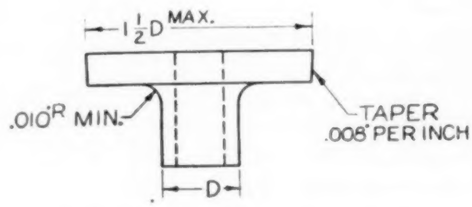

FIG. 4 CORRECT-FLANGED PART DESIGN

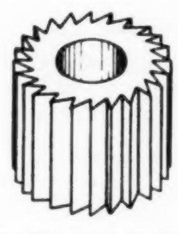

FIG. 7 ONE FORM OF SERRATION

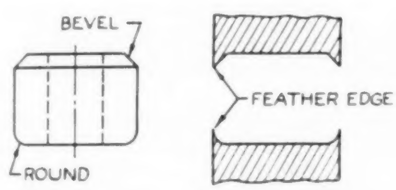

FIG. 5 PUNCH CONSIDERATIONS

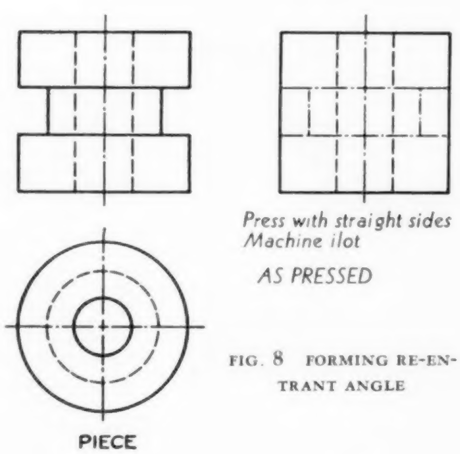

FIG. 8 FORMING RE-ENTRANT ANGLE

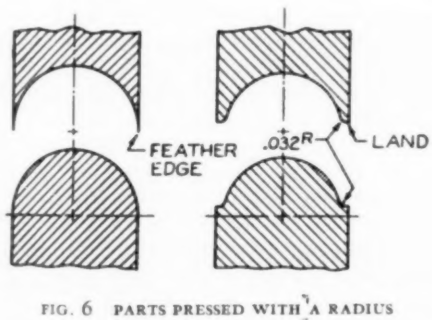

FIG. 6 PARTS PRESSED WITH A RADIUS

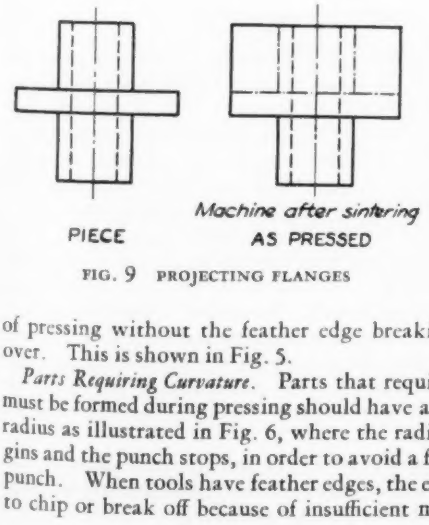

FIG. 9 PROJECTING FLANGES

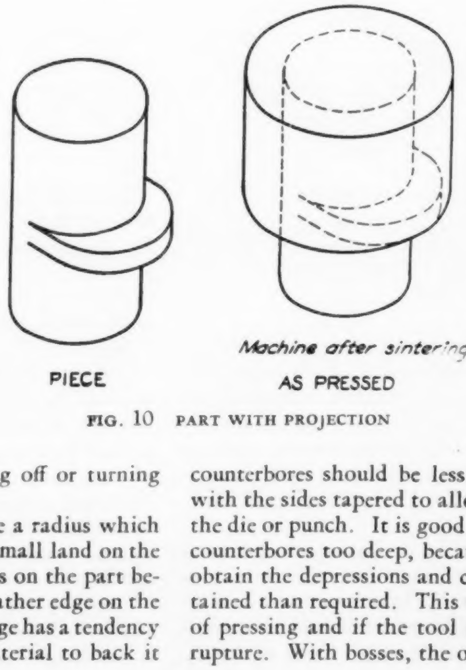

FIG. 10 PART WITH PROJECTION

Parts Requiring Curvature. Parts that require a radius which must be formed during pressing should have a small land on the radius as illustrated in Fig. 6, where the radius on the part begins and the punch stops, in order to avoid a feather edge on the punch. When tools have feather edges, the edge has a tendency to chip or break off because of insufficient material to back it up. When pressure is applied the tool chips or turns over, producing a ragged section on the part.

Inserts. Inserts are normally put into the part at the time of pressing but may be pressed into the part after sintering. When a powder-metallurgy part is to be used as an insert, as in plastic molding, vertical serrations parallel to the axis of pressing can be put on the outside diameter serving the purpose of knurling which otherwise would require a secondary operation. Fig. 7 shows one type of serration.

MACHINING OPERATIONS NECESSARY FOR SOME PARTS

Parts With Re-Entrant Angles. Parts that have re-entrant angles or curves in the axial direction cannot be pressed because presses now used for powder metallurgy have only a straight up-and-down motion with no side motion or pressure available to compress the powder to make a re-entrant angle or curve. Under these circumstances a secondary operation is required. Fig. 8 shows how the part could be produced.

Flanged Projections. Parts that have flanges projecting from the center of the body or more than one quarter of the length from the end, are difficult to form unless complicated dies and punches are used to move the powder to the desired position in the die in order to obtain the required density and help eject the part from the die. Even with complicated dies and punches, it is difficult to say that a perfect part could be produced without breakage or cracking and uneven density. With this type of design a secondary operation would be required, as shown in Fig. 9.

Axial Variations. When parts have axial variations greater than one half of their length, care must be taken to obtain the proper ratio between the die fill and the compressibility of the powder in order to obtain the required density and size.

Parts that have odd shapes and heights greater than one quarter of their length should be redesigned to meet the powder-metallurgy technique, so that the part when finished will meet the required specifications and can be ejected from the die. This is shown in Fig. 10.

Depressions, Bosses, and Counterbores. Depressions, bosses, and counterbores should be less than one-quarter axial variation, with the sides tapered to allow the part to be drawn loose from the die or punch. It is good practice not to have depressions or counterbores too deep, because when the powder is pressed to obtain the depressions and counterbores, greater density is obtained than required. This will strain the punches at the time of pressing and if the tool is light in design it will perhaps rupture. With bosses, the opposite reaction takes place; if the

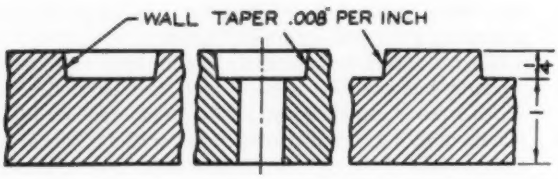

FIG. 11 DEPRESSION, COUNTERBORE, AND BOSS

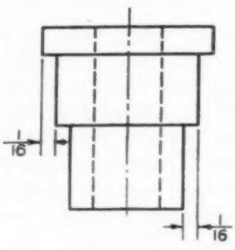

FIG. 12 DESIGN OF STEPPED PART

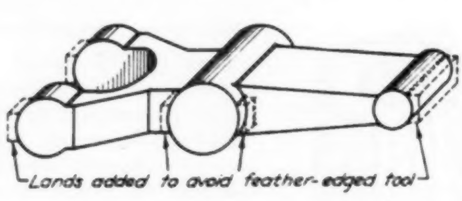

FIG. 15 CHANGES NECESSARY TO ELIMINATE FEATHER EDGES ON TOP AND BOTTOM PUNCHES

(The projections or lands on the radius help to eliminate breaking of the edges on the punches during the pressing operation.)

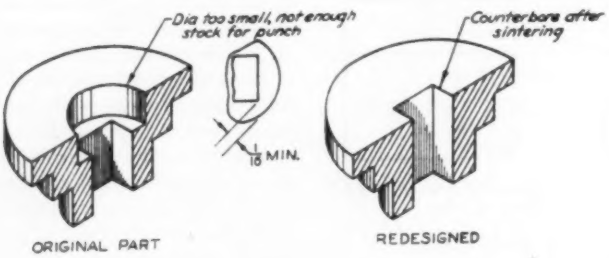

FIG. 13 PART WITH SQUARE SECTION AND COUNTERBORE

(In the case of this design, the tool to produce the counterbore with a square section would have a weak portion which would rupture during the pressing operation.)

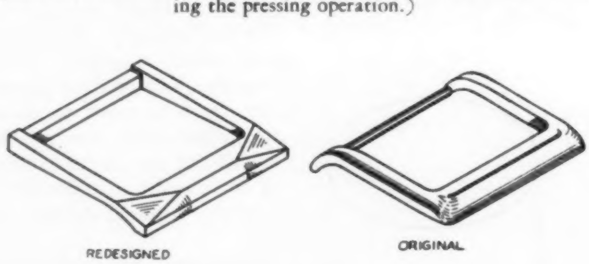

FIG. 14 ORIGINAL AND REDESIGNED PART

(To produce a part to meet the specifications, it was necessary to redesign along straight lines, eliminating the curved section. This insures better pressing and the required density and strength necessary for the part.)

required boss is too high and no means of moving the powder to obtain the required density is undertaken, a part with less density is obtained resulting in a weak structure. The designer will have to study each individual part. A good rule to follow is to have the depressions, bosses, or counterbores not over one quarter of the total length or section of thickness, with a taper of about 0.008 in. diam for each inch in depth. Fig. 11 illustrates this.

Steps. Where steps are formed in the design, each step should be at least $1/8$ in. larger in diameter than the preceding step. As these steps are sometimes formed either by steps in the die or by a secondary die or punch, enough shoulder should be formed so that there will be sufficient strength in the part, especially

TABLE 1 RECOMMENDED TOLERANCES

Tolerances on length	
±0.005 in.	up to 1 in. long
±0.010 in.	up to $1^1/_2$ in. long
±0.015 in.	up to 2 in. long
±0.020 in.	up to $2^1/_2$ in. long
±0.025 in.	up to 3 in. long
Parts pressed and not coined to size-diameter tolerance	
±0.0015 in.	up to 1 in. diam
±0.002 in.	up to $1^1/_2$ in. diam
±0.003 in.	up to 2 in. diam
±0.004 in.	up to $2^1/_2$ in. diam
Tolerances on flange diameters	
±0.004 in.	up to 1 in. diam
±0.006 in.	up to $1^1/_2$ in. diam
±0.008 in.	up to 2 in. diam
±0.010 in.	up to $2^1/_2$ in. diam
±0.014 in.	up to 3 in. diam
±0.016 in.	up to 4 in. diam
Tolerances on flange thickness	
±0.004 in.	up to $1/4$ in.
±0.006 in.	up to $3/8$ in.
±0.008 in.	up to $1/2$ in.
Concentricity	
0.003 in. total indicator reading	up to 1 in. diam
0.004 in. total indicator reading	up to $1^1/_2$ in. diam
0.005 in. total indicator reading	up to 2 in. diam
0.006 in. total indicator reading	up to $2^1/_2$ in. diam

TABLE 2 RATIOS BETWEEN WALL THICKNESS IN RELATION TO DIAMETER AND LENGTH

Minimum wall thickness, in.	Maximum over-all length, in.	Maximum outside diameter, in.
0.032	$1/2$	$1/2$
0.040	$5/8$	$3/4$
0.045	$3/4$	1
0.050	$7/8$	$1^1/_8$
0.055	1	$1^1/_4$
0.060	$1^1/_8$	$1^3/_8$
0.065	$1^1/_4$	$1^1/_2$
0.070	$1^3/_8$	$1^5/_8$
0.075	$1^1/_2$	$1^3/_4$
0.080	$1^5/_8$	$1^7/_8$
0.085	$1^3/_4$	2
0.090	$1^7/_8$	$2^1/_4$
0.095	2	$2^1/_2$

when it is necessary to make the step with a secondary die or punch. If the diameter of the step is too small, inadequate powder fill will result, thus defeating the purpose of the design, Fig. 12.

SECONDARY OPERATIONS

Inasmuch as parts made by the powder-metallurgy technique will not meet all of the requirements of a finished part, secondary operations are sometimes necessary, such as drilling, tapping of holes on the side of the part, tapping of holes formed by the pressing operation, recesses on the end where it would be impossible to press the shape, and the turning of steps that have a diameter only slightly larger than its preceding step.

Along with these factors, the designer must make certain that the design is such as would normally require a considerable cost of machining, as compared to the cost of the part pressed from powdered metals. Reasonable quantities, as well as other factors, are largely related to the design of the part. The more complicated the machining of the part is by conventional methods, the greater the annual saving will be in increased production where parts are made by the powder-metallurgy process.

Tables 1 and 2 and Figs. 13, 14, and 15, may assist the designer to determine the proper tolerances and changes in design when designing parts for powder metallurgy.

ELECTROHYDRAULIC CONTROL *of* DIESEL-ELECTRIC DRIVES

By C. B. Lewis[1] and M. A. Edwards[2]

GENERAL ELECTRIC COMPANY

THE use of Diesel-electric drives presents several important problems which must be recognized and to which considerable attention must be given in order to secure the most favorable operation of the power plant.

These problems include the following:

1 Speed control with small transient regulation over a wide speed range.

2 Load control to match generator demand and engine ability.

3 Fuel limit as a function of engine speed.

4 Engine protection.

5 Remote control and multiple-unit operation.

The control must operate stably over a wide speed range, permitting the use of the lowest possible engine speed commensurate with the power requirements, thus minimizing engine wear and fuel consumption. Transient speed regulation should be low to shorten the time duration of off-speed operation because of variation in load demand.

The generator demand must be limited to engine ability at any given speed setting to avoid stalling and the resultant harmful thermal overloading of the engine. This is particularly important since a bogged engine not only gives lowered performance but if continued may cause serious damage to the engine.

Fuel should be reduced at lowered speeds to prevent thermal overloading of the engine. This is particularly true of the larger supercharged engines because of the decrease in air density of the cylinder charge with lowered speeds. If a full torque charge of fuel is burned with a decreased weight of air, the mean cycle temperature increases and the engine becomes overheated. In normally aspirated engines, the limiting of fuel at reduced speeds becomes increasingly important as the operating speed range increases.

Definite measures must be provided to protect the Diesel engine from permanent damage by (1) overspeeding of engine; (2) loss of lubrication; (3) high engine temperatures. With an engine costing many thousands of dollars the reliability and ease of providing shutdown protection because of misoperation is of prime importance.

With the application of Diesel-electric drives to transportation, the ease of accomplishing both remote control and multiple-unit operation becomes highly important because of the premium on the volume occupied by the physical components of the control and the necessity for all engines to respond to the desired speed-torque characteristics. In other fields, the use of remote, automatic, or semiautomatic control is becoming increasingly popular.

DESCRIPTION OF CONTROL

Speed Control. The governing system consists functionally of a speed-measuring means, load control, fuel control, suitable stabilizing, and a power servomechanism. These functions may be produced by a variety of means, but after careful consideration the combination of electrical and hydraulic components was chosen because of their inherent characteristics and reliability.

Referring to Fig. 1, speed-measuring is accomplished by using an a-c tachometer-generator driven by the engine in combination with a dry-plate rectifier. The a-c tachometer was chosen in preference to the conventional d-c tachometer because of its greater reliability. The output of the three-phase tachometer is rectified using a three-phase full-wave selenium rectifier whose negative temperature coefficient tends to temperature compensate the tachometer and solenoid.

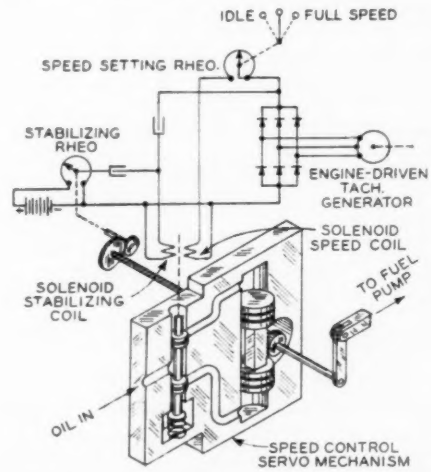

FIG. 1 FUNCTIONAL DIAGRAM OF SPEED CONTROL

The rectified voltage developed by the engine-driven tachometer produces a current which b ecomes a solenoid force proportional to speed and inversely proportional to circuit resistance. The solenoid force is compared with the reference spring force and, when the two forces are equal, the pilot valve is in its mid-position and the system is in equilibrium. A load change, causing a speed change, results in a change of solenoid force, and the pilot valve is moved by the difference of the solenoid force and reference force. The movement of the pilot valve causes the slave cylinder to act on either the engine fuel or generator excitation, or both, depending on the nature of the load change, and in a direction to restore the system to balance conditions.

The solenoid characteristic curve, Fig. 2, which is a plot of pilot-valve movement versus solenoid force (or ampere turns), indicates the governor sensitivity as a function of the slope of the curve. Applications have been made where a speed change of 0.05 per cent produces sufficient motion of the pilot valve to operate the servomechanism. This high degree of sensitivity

[1] Transportation Control Engineering Division. Erie, Pa.

[2] General Engineering and Consulting Laboratory. Schenectady, N. Y.

Contributed by the Oil and Gas Power Division and presented at the Spring Meeting, Chattanooga, Tenn., April 1–3, 1946, of The American Society of Mechanical Engineers.

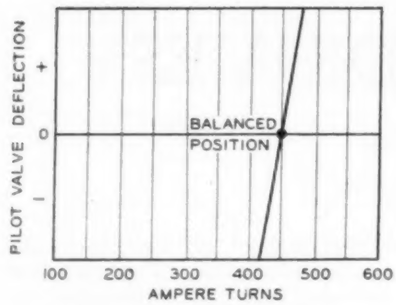

FIG. 2 SOLENOID FORCE-DEFLECTION CHARACTERISTIC

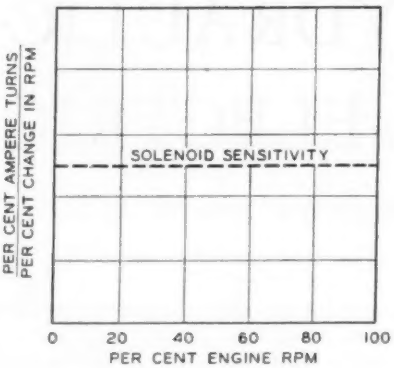

FIG. 3 SOLENOID-SENSITIVITY CHARACTERISTIC

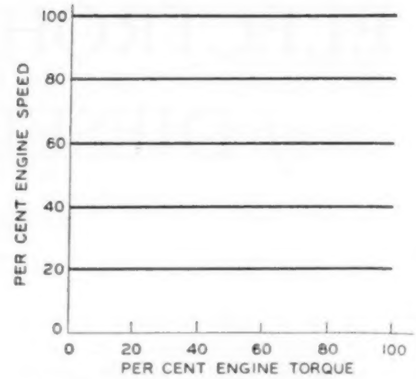

FIG. 4 POWER-PLANT SPEED-TORQUE CHARACTERISTIC

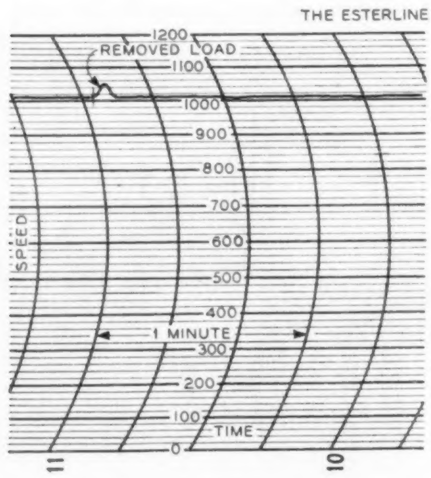

FIG. 5 TIME-SPEED CURVE

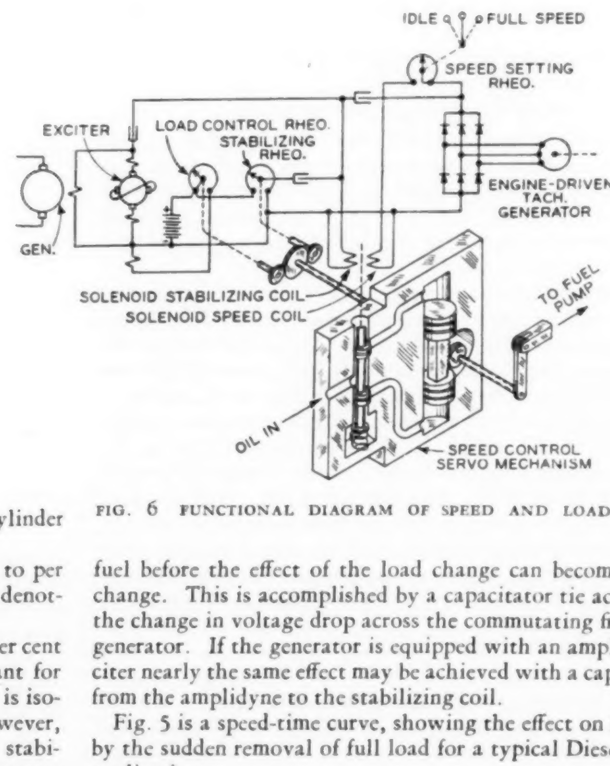

FIG. 6 FUNCTIONAL DIAGRAM OF SPEED AND LOAD CONTROL

together with a rapid response permitted the slave cylinder minimizes the transient speed regulation.

Fig. 3 is a plot of the ratio of per cent ampere turns to per cent change of rpm versus rpm, the curve is horizontal, denoting constant sensitivity over the entire speed range.

Examination of Fig. 4, which is a family of curves of per cent speed against engine torque, shows the speed is constant for any particular engine torque, and indicates the governor is isochronous and has no speed droop with engine load. However, with any isochronous-type governor, some restoring or stabilizing means is necessary. Two stabilizing functions are provided which give a stabilizing signal to the solenoid (1) as a rate of change of fuel or slave-cylinder movement, and (2) a rate of change of speed. Stabilizing as a rate of change of slave-cylinder motion is produced by a transient-current flow through capacitors and stabilizing coil caused by a motion of the voltage-dividing rheostat which is geared directly to the slave cylinder. Stabilizing as a rate of change of speed is produced by the current flow through capacitors between the tachometer-generator and stabilizing winding and gives a signal ahead in time-phase relation to the stabilizing produced due to the rate of change of fuel by the amount of time lag of the servomechanism. The stabilizing signals proportional to the second and first derivative of speed are considerably more effective than a stabilizing signal that is only proportional to a change in speed.

Further reduction in transient regulation is obtained from the measurement of rate of change of load and produces a change in fuel before the effect of the load change can become a speed change. This is accomplished by a capacitator tie actuated by the change in voltage drop across the commutating field of the generator. If the generator is equipped with an amplidyne exciter nearly the same effect may be achieved with a capacitor tie from the amplidyne to the stabilizing coil.

Fig. 5 is a speed-time curve, showing the effect on full speed by the sudden removal of full load for a typical Diesel-electric application.

Load Control. Load control or matching the generator demand with engine ability is a further means of speed control since the generator output is limited to exactly the same amount as the engine ability and eliminates any effect on speed due to change in engine efficiency. Referring to Fig. 6, load control is accomplished by a control rheostat in the exciter field which is actuated by the servomechanism after maximum allowable fuel has been supplied to the engine.

Fig. 7 is a volt-ampere characteristic of the generator. The generator parametric curve is shown by the dashed line, the solid curve is constant volt-amperes or constant horsepower, and the crosshatched portion is the amount of alteration of the generator characteristic by the load-control rheostat necessary to match generator demand and engine ability. The same principle of operation applies to reduced speed and power over the entire speed range.

Fuel Limit. Fuel limit as a function of engine speed is pro-

vided by the use of a position-setting rheostat which is operated simultaneously with the speed-control rheostat, as shown by Fig. 8. This changes the solenoid current, causing the hydraulic slave cylinder to move both the fuel stop and a follow-up rheostat until the solenoid current has returned to normal. The fuel stop is a cam operated by the fuel limit servo, limiting the rotation of the main output shaft of the governor, but not restricting the operation of the load-control rheostat.

Engine Protection. Overspeed protection of the engine is

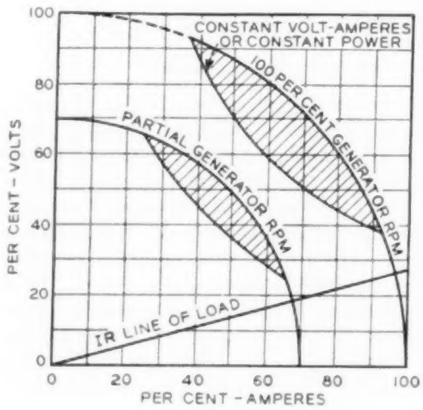

FIG. 7 GENERATOR VOLT-AMPERE CHARACTERISTICS

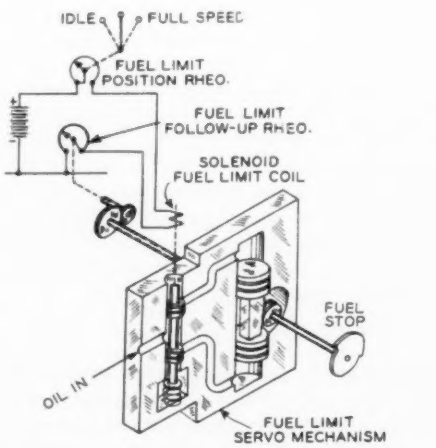

FIG. 8 FUNCTIONAL DIAGRAM OF LOAD CONTROL

provided by the combination of a magnetically locked spring-restored coupling and a centrifugal switch. Operation of the centrifugal switch due to overspeed removes excitation from the magnetic lock, allowing the stored energy in the spring to remove fuel from the engine. Protection against loss of lubrication is attained by a pressure-operated switch in series with the centrifugal switch; also a thermally operated switch may take care of high-temperature protection. If any other protection is desired, this can be accomplished in the same manner by adding separate switches in series with the centrifugal switch and the magnetic lock.

Remote Control and Multiple Unit. Remote operation of this type of control is accomplished by locating the speed-control rheostat at the operating station, or to commutate the speed-control resistance by the use of remotely operated relays. In other applications, the speed-control resistance has been successfully replaced by a variable bias voltage. It is obvious that multiple-unit operation can be readily accomplished by simultaneously controlling the speed and limit setting resistances of all the units. In cases where extremely accurate speed synchronism is required, a third coil may be added to the speed solenoid and, by astatic connections between the speed generators and a common bus, it is possible to force all the prime movers to run at exactly the same speed.

CONCLUSION

Fig. 9 is a functional diagram showing the integration of the complete governing system, and Fig. 10 shows a typical electrohydraulic regulator for transportation application.

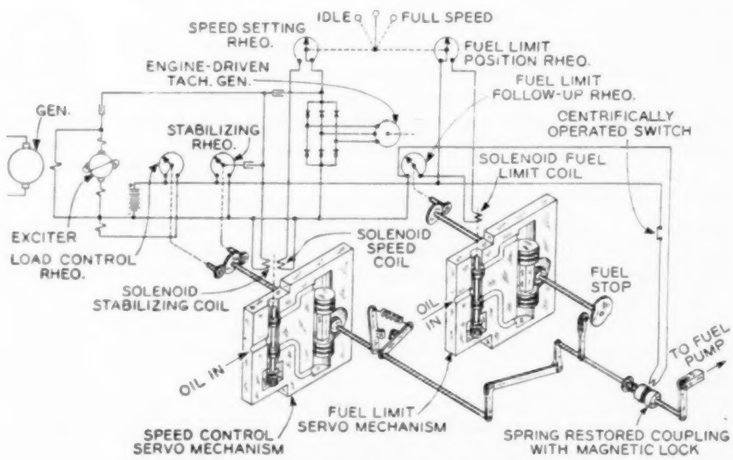

FIG. 9 FUNCTIONAL DIAGRAM OF CONTROL SYSTEM

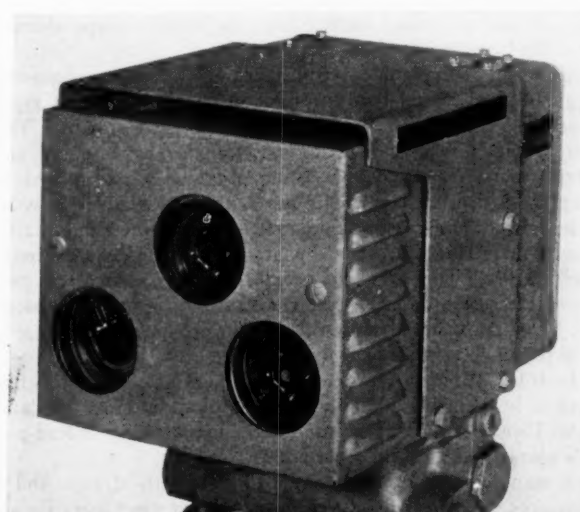

FIG. 10 AN ELECTROHYDRAULIC REGULATOR

The control has been in use for several years in both military and commercial applications and the field experience indicates high reliability. Also, the flexibility of arrangement of component parts makes it easy to change the configuration of the system to suit specific applications and allows considerable freedom in the over-all integration of the complete drive.

The MANUFACTURE *of* WOOD-CASED PENCILS

By CHARLES R. NICHOLS, JR.

DIRECTOR OF ENGINEERING, JOSEPH DIXON CRUCIBLE COMPANY, JERSEY CITY, N. J. MEMBER A.S.M.E.

HISTORICAL REVIEW

PROBABLY the pencil was the first instrument used by artists and in its earliest form consisted simply of a lump of colored earth or chalk cut into a convenient form for holding in the hand. The use of metallic lead for marking is of very ancient origin and its use was continued well into the nineteenth century. Ultimately, lead pencils were made using graphite or plumbago containing no lead whatsoever. Since the mark made by graphite was extremely black in comparison with the pale mark of metallic lead it was called black lead. Therefore, because graphite or plumbago was referred to as black lead we still call pencil-type writing instruments lead pencils.

The first discovery of graphite occurred at Barrowdale, England, in 1554. Graphite-type lead pencils were produced shortly afterward in 1564. Originally, graphite was cut into small square-shaped strips and glued into wood casings. This type of pencil was in common use until 1796 when Nicolas Jacques Conté, a French painter, chemist, and mechanical genius, devised the basic method used today in the manufacture of lead pencils. All black lead pencils, made up to and including the Centennial in Philadelphia in 1876, contained square leads and the author's company is credited with the manufacture of the first round leads, changing to this shape shortly after the Centennial year.

After the Barrowdale graphite mines became exhausted, England lost her leadership in the industry, and in 1761 Casper Faber first produced lead pencils in Nürnberg, Germany. The first pencil factory in America was founded by a school girl whose name is not known. She obtained a few pieces of graphite from the Barrowdale mine, crushed them to powder either with a hammer or stone, and then employed gum, mixing the two together, and stuffed a hollowed-out alder twig with the mixture. This first lead pencil made in America was produced at Danvers, Mass. Later, a man by the name of Joseph W. Wade co-operated with this girl in producing a number of lead pencils by the same process.

In 1812 William Monroe of Concord, Mass., made the first pencils in quantity and sold them throughout New England. John Thoreau followed Monroe in the manufacture of lead pencils also in Concord in the year 1823.

A man named Wood associated himself with Monroe and to him goes the credit for developing the first machinery for the production of lead pencils. He was responsible for the adaptation of the circular saw and a series of knives to the shaping of the wood. Joseph Dixon, the founder of the author's company, used the same system at about the same time, but it was not until 1872 that the Dixon Company, founded in 1827, sold its first lead pencils on a commercial scale.

The complete history of the evolution of the lead pencil is an extremely fascinating study, but the brief summary presented here is sufficient for the purposes of this paper.

GENERAL CONSIDERATIONS

Since we are primarily interested in the woodworking phases of the pencil industry at this time, all other operations will be covered briefly. Sufficient information will be provided, however, to tie together the complete sequence of operations, but the woodworking operations will be covered in detail.

Lead pencils are designed for a purpose diametrically opposed to the purposes for which most wood products are produced. In short, they are designed for destruction, and yet the unused portion of a pencil must remain sturdy and pleasing to the eye. Since wood is the material representing the major portion of a pencil, it must be selected for characteristics which lend themselves to strength, freedom from warpage, and smooth cutting qualities.

At the present time the pencil manufacturer is faced with the necessity of producing not only the well-known black lead pencils, but must also supply a variety of colored leads in wood cases. These colored pencils can be roughly divided into three types, i.e., indelible, crayon, and water-soluble leads. In all cases the woodworking processes are similar. In 1942 the United States alone produced approximately 10,000,000 gross or 1,440,000,000 pencils. This is the equivalent of $10^1/_4$ pencils per year for every man, woman, and child in this country.

Many types of raw materials are used in the manufacture of a wood-cased pencil and a list of those used in large quantities follows: Wood, graphite, clay, gums, pigments, dyes, waxes, adhesives, rubber, brass, plastic, lacquer, and metallic foils. In addition to the major raw materials listed, there are countless numbers of materials used in small quantities.

LEAD MANUFACTURING

Black pencil leads contain four general types of ingredients, i.e., graphite, clay, gums, and waxes. The hardness of the lead is controlled by the relative proportions of clay and graphite. Obviously, the higher the clay content the harder the lead. Black leads are produced in many grades or degrees of hardness. For instance, there are seventeen degrees available in a top grade of drawing pencil. These are designated from 6B to B, HB, F, and H to 9H, in that order, running from the softest to the hardest grades. The clay and graphite are mixed thoroughly in a large volume of water and, after thorough agitation the slurry is passed through a blender and subsequently the water is removed. The resultant mixture which is now thoroughly dry is placed in an intensive mixer and an exact percentage of water is added, generally 15 to 20 per cent, depending upon the formula. The proper gum is also added at this point, and after thorough mixing the material is transferred to a large hydraulic press where it is extruded through a screening die. This operation is called "rough" pressing. The extruded material is then processed in a 3-roll mill and is again rough-pressed. These operations may be repeated several times depending upon the quality of the lead desired. Every possible operation is performed on the lead which tends to produce a smooth, uniform, and strong writing medium.

Contributed by the Wood Industries Division, for presentation at the Annual Meeting, New York, N. Y., December 2–6, 1946, of The American Society of Mechanical Engineers.

The graphite itself is processed through a micronizer after purification, in order that the finest possible particle size may be obtained. The average graphite flake in the better grades of leads is extremely small, usually in the very low micron range.

From the final rough-pressing operation the material is transferred to a finish press where it is extruded through a die of diamond, agate, or sapphire. These dies are made very accurately so that the extruded lead will dry to the desired diameter. In the case of leads intended for wood-cased pencils the diameter is maintained within tolerances of plus or minus 0.001 in., whereas small-diameter leads used for mechanical pencils are maintained within plus or minus 0.0005 in. This order of accuracy is necessary so that a proper fit can be maintained when the leads are put to use.

Coils of extruded lead are removed from the finish presses and are laid on boards approximately 2 ft long. Each strand of lead is laid parallel to the one adjacent to it until the whole board is completely filled. Some companies perform this operation by hand, and others use various automatic mechanical methods. A rubber mat is placed over the tray and the trayful of leads is placed in a rack to dry.

After drying, the leads are cut to a length of approximately $7^5/_{16}$ in. and burned. One method of burning involves placing the leads in a refractory box made from clay and graphite, completely burying them in graphite, and placing a cover over the box and sealing with a refractory cement. These boxes of leads are then placed in a kiln where they are fired at high temperature. In some plants the leads are placed in metal boxes, buried in graphite, covered, and passed through a continuous electric kiln. The desired temperature is accurately maintained with automatic-control instruments. After cooling and removal from the boxes, the leads are impregnated in a bath of molten wax maintained at an exact temperature.

Colored leads are made in the same general way except that the burning operation is eliminated and a regular sigma-arm-type mixer is substituted for the preliminary slurry type of blending.

Accessories. A large percentage of pencils are provided with erasers and ferrules, commonly referred to in the industry as caps and plugs. Caps are generally of two types, brass or plastic. The plugs are made from ordinary eraser material composed of rubber, filler, and fine abrasive.

Plastic caps are generally made by the injection-molding process, and some type of decoration such as stripes of lacquer may be added as desired. Brass caps are made on standard eyelet machines, are knurled with the desired design, and are finally lacquer-coated to prevent tarnishing.

The method used in the manufacture of erasers or plugs is quite standard and well known throughout the rubber industry. The pencil-eraser shape is produced by extruding the milled stock through tubing machines, after which it is vulcanized, cut to length, and tumbled.

GENERAL WOOD PROCESSING

The United States has grown the best wood for pencils up to the present time. Originally, the fragrant red cedar known as Juniperus Virginiana grown in several of the southern states was used almost exclusively in the manufacture of wood-cased pencils. The supply of this cedar has been nearly exhausted and to a large extent has been replaced by western incense cedar from California. This is known as Libocedrus Decurrens Torr.

Before it was discovered that the western cedar was suitable for the manufacture of pencils, the larger pencil manufacturers combed the southern states for all available cedar lumber. They even purchased piles of cedar, fence rails, posts, old log cabins, shacks, and barns. All old structures containing cedar were torn down and the wood stored for future use. The characteristics desirable for pencil wood are unique and are satisfied completely only by the types of cedar mentioned. The grain must be straight, the wood must be relatively soft, must take a good finish, and must have reasonably high resistance to breakage across the grain.

The logging operation is parallel to that used in other wood industries, although the cedar trees make up a relatively small percentage of those found in any particular stand of timber. Generally, it grows along with other types of wood such as pine. After felling, the logs are seasoned and sawed to length, ripped into boards, and shipped to a slat mill. At the slat mill the logs are sawed into blocks approximately $2^1/_2$ in. $\times$ $2^1/_2$ in. in cross section and $7^5/_{16}$ in. long. These blocks are then resawed on gang-saw tables into slats approximately $2^1/_2$ in. wide, $7^5/_{16}$ in. long and $^3/_{16}$ in. thick. Actually, the pencil industry uses the metric system in measuring width and thickness. No exact width and thickness can be given since the final size of the pencil determines the original thickness of the slat, and the condition of the original cedar log determines the width. An attempt is made to use all of the wood in a log, but unfortunately, most trees contain large areas of rot, irregular cross section, and knots. The ideal slat for the average pencil should measure 65 mm in width and $4^1/_2$ mm in thickness.

After the cedar is cut into slats it is kiln-dried, stained to a uniform color in pressure vats, and is then impregnated with wax. The wax is added for the purpose of providing a smooth-cutting wood and to prevent the grain from raising during the finishing operation.

After the slats are finished they are inspected, sorted, and graded and are ready for manufacturing into pencil casings.

In most cases the wood slats must be shipped to the factory in which they are to be converted into pencils. Upon receipt they are stored in designated areas according to classification, which involves selection according to quality and ply. In the pencil industry the term ply indicates the number of half pencils which can be cut from a single slat, and, ordinarily, all slats of identical width or ply are processed together. This procedure reduces to a minimum the number of times a shaping machine must be set up.

The wooden slats are taken from storage and passed through grooving machines parallel to the longitudinal axis. These groovers are built according to the same principles employed in molding machines or stickers used in the manufacture of dowel sticks. These machines ordinarily have an upper and lower head, each of which takes care of one side of the slat. One head faces the upper side of the slat and squares the longitudinal edges. The second or lower head faces the opposite side of the slat and cuts the semicircular grooves into which the leads are placed. Reference to Fig. 1 will show the appearance of a typical slat completely machined. General tolerances are indicated also.

The tolerances in this phase of the operation are of necessity extremely close, since the accuracy of successive operations and the quality of the ultimate product depend entirely on the care and precision used in the machining operations. The center distances between the individual leads are maintained within tolerances of plus or minus 0.0005 in. and the finished thickness is maintained within plus or minus 0.001 in. The diameters of the lead grooves are also maintained within tolerances of the same order.

The face of the slat on the grooved side must be absolutely flat and smooth in order to guarantee a first-class glue joint, and it will at once become evident that the center distances between the leads must be maintained in order that two slats may be properly aligned face to face and so that the pencils which are finally shaped may have the leads concentrically disposed within their cross-sectional area.

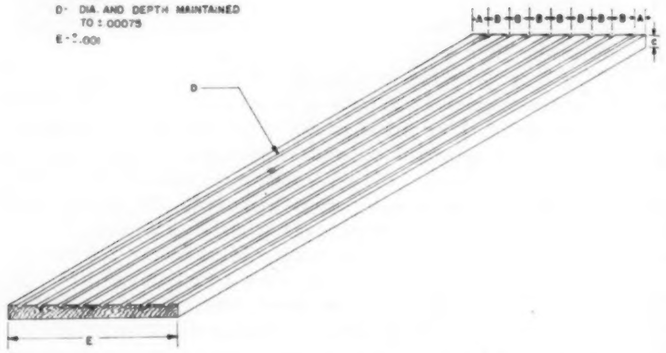

FIG. 1 PENCIL SLAT IMMEDIATELY FOLLOWING GROOVING OPERATION

It is necessary to perform the subsequent manufacturing steps as soon as possible after the grooving operation, and the temperature and humidity conditions must be maintained within reasonable limits so that the physical dimensions of the wood will not change materially until the pencils are finished. A slight change in moisture content will materially affect the required tolerances, and warpage can cause all manner of trouble in successive stages, namely, during the gluing, shaping, and finishing operations.

LEADING PROCESS

The next process is one referred to in the pencil industry as leading. As the name implies, the leads are placed in grooves in one slat. This operation can be performed by hand or by mechanical means and both methods are used. Hand-leading is one of the most dexterous operations performed in the manufacture of pencils, requiring several months to train a normally dexterous person to become a satisfactory leader. The operation is ordinarily performed by holding a bundle of leads in one hand and by proper use of the fingers fanning the exact number of leads required into position in the slats while the other hand is used to move unfilled slats into position.

Several types of automatic leaders have been developed by various companies and are in common use. When automatic leaders are used it is obvious that the individual leads must be mechanically spaced and this immediately makes it necessary to maintain close tolerances in the slat groove spacing, in the size of the grooves themselves, and in the diameters of the leads. Automatic operations in general cannot be made as flexible as hand operations and automatic pencil machinery is no exception to the rule. It is apparent that a bowed or crooked lead, a warped slat, or nonadherence to dimensional tolerances would make it impossible to fit the leads to the grooves. Conditions of this kind will either produce pencils of inferior quality or may at worst prevent the performance of the next operation. All difficulties of this nature must be corrected and if too many corrections become necessary production costs will become excessive.

GLUING OPERATION

Under the general subject of gluing we refer to the use of any type of adhesive which may be used in the manufacture of pencils. Ordinarily, a first-quality hide glue is used and experience has shown it to be quite satisfactory. Earlier in this discussion it will be recalled that the wood itself is impregnated with wax and, although it is necessary for producing a wood with satisfactory characteristics, it also creates a problem in the gluing operation. Some adhesives ordinarily satisfactory for wood are absolutely useless in producing a satisfactory bond in the pencil industry.

Standard methods of glue application are used varying from a hand-and-brush application to mechanical spreading. As in all wood industries, a uniform application of the adhesive is absolutely necessary in order to produce a uniform high-quality bond. In some cases the adhesive is applied to one slat and in other cases to both slats. Both methods have been used successfully.

Following the application of the adhesive, the slat filled with leads is covered with a second slat, producing a "sandwich," in which the leads become the filler. This combination of two slats, leads, and adhesive is called a "block." These blocks are stacked in a clamp and the whole assembly is pressed together in a hydraulic or pneumatic press, the pressure of which is accurately and automatically controlled. As soon as the desired pressure is reached the clamps are locked, holding the blocks at that pressure, after which they are removed from the press and put into storage for drying. The drying period may vary from 24 hr to 5 days, depending upon the adhesives and drying methods used. All types of conventional drying methods are used among the various manufacturers.

BLOCK GRINDING AND SHAPING

After the required drying period has elapsed the blocks are removed from the clamps and are passed through a machine called a "block grinder." This equipment may be composed of a set of cutters or some type of sandpaper carrier such as a drum or belt. The purpose of this machine is to square off the ends of the blocks and to remove any excess lead which may protrude beyond the ends of the wood, or any excess glue which may have squeezed out during the clamping operation.

From the block grinder the blocks are moved to shaping machines which are similar to the grooving machines mentioned earlier. The chief difference between the two types of equipment is the shape of the cutters. Since the cutters on the shapers produce the final cross-sectional form of the pencil, they must be machined and ground to the conformation desired.

Generally, pencils are finished in a round or hexagonal shape, and each cutter of the two required forms one half of the pencils cut from the blocks. The outermost periphery of the cutting circle extends slightly beyond the glue joint so that the pencils after passing through the second cutter head have all excess wood cut away. A block which has completely passed through the first or top head and partially through the second or bottom head is illustrated in Fig. 2.

Again, in this operation, extreme accuracy is an absolute

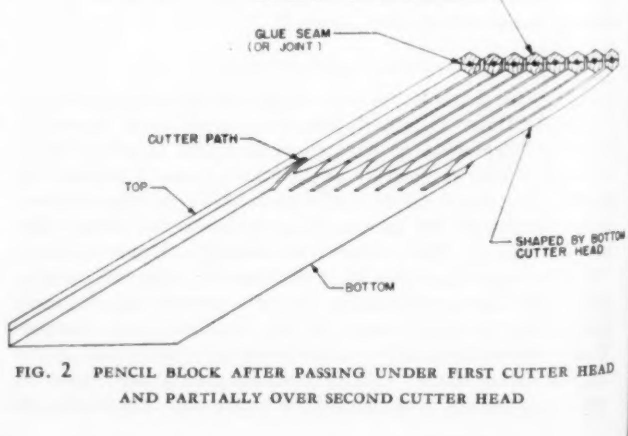

FIG. 2 PENCIL BLOCK AFTER PASSING UNDER FIRST CUTTER HEAD AND PARTIALLY OVER SECOND CUTTER HEAD

necessity. All the reasons mentioned for the grooving procedure are true of this operation with two other requirements added. The shape of the external surface of the pencil must be absolutely uniform and accurate to plus or minus 0.001 in., in order that the finishing operation can be properly performed. Furthermore, the position at which the cutter paths cross the glue line must be so accurately maintained that no ledge or fin shows on the surface of the pencil. Again, the finishing operation makes this necessary and, in addition, any subsequent sanding operation would be too costly if an excess of wood had to be removed. Finally, the finished pencil must be absolutely smooth and uniform without any indication of the location of the parting line or glue seam.

At this point it is interesting to note that two methods are used in the shaping of hexagonal pencils. One method involves the inclusion of three complete panels in each cutter head with the resultant glue seam running from corner to corner. The top and bottom panels are horizontal and parallel to the flat surfaces of the block. The panels on either side of the glue joint are disposed at 60 deg with reference to the plane of the glue seam. Fig. 3 shows the resultant position of the cross-sectional area of the shaped pencil with respect to the glue line when using this method.

The second method provides two full panels and two half-panels on either side of the glue seam. The two full panels are located at the top and bottom of the block, each being disposed at an angle of 30 deg with reference to the glue seam or the horizontal surfaces, and the two half-panels are normal to the horizontal. Fig. 4 shows the positioning of the panels when this cutting practice is employed.

Where the second method is used it is even more imperative to provide accurate cutters properly adjusted, because the second cutter head overlaps the path of the first cutter head on the same panel.

From a mechanical standpoint, the first method is preferable because adequate cutter clearance is provided automatically, and extremely thin partings are not necessary. If heavy partings are used on cutters of the second type a serious loss in material results. Theoretically, for maximum economy in wood, the partings should have zero thickness.

SANDING TECHNIQUE

From the shaping machines the individual pencils are transferred to sanding equipment. Several types of sander are used throughout the industry. Two of the better known varieties involve the use of reciprocating pads holding the abrasive paper and provided with automatic turning devices between each pad in order that a new flat surface may be presented to each successive sanding pad where the operation is being performed on

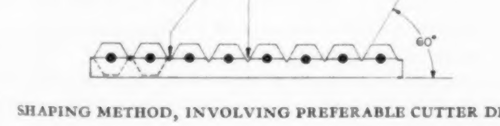

FIG. 3 SHAPING METHOD, INVOLVING PREFERABLE CUTTER DESIGN

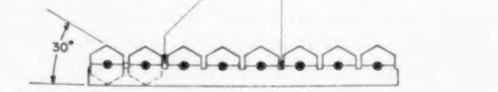

FIG. 4 SHAPING METHOD, USING CUTTERS WITH THIN PARTING BLADES

hexagonal-shaped pencils. Round pencils are turned continually, of course. The second type of sander is made up of a series of sanding belts each one of which smooths a separate surface. In general, the quality of the final product determines the number of passes through the sanding equipment.

Immediately following the sanding operation the pencils are inspected for imperfections. Faults may include warpage, cross grain, defects in the wood, off-center leads, short leads, etc. All pencils which pass this inspection point are taken to the finishing operation.

FINISHING OPERATIONS

Many years ago pencils were finished by hand, but at present all pencils manufactured in the United States are finished by the same general method. The process involves passing the pencils, one following another, through a bath of lacquer or other finishing material and scraping off the excess material by passing them through a rubber gasket provided with a hole conforming to the external shape of the pencil. At this point it will become increasingly obvious that exact adherence to dimensional tolerances is necessary for both the pencil and the gasket. Any deviation from exact measurements will create uneven coating and may, in fact, prevent complete coverage of one or more panels or corners.

Each pencil is passed through these gasket-type machines from 3 to 12 times, depending upon the quality of finish desired. A good grade of pencil will be finished with approximately seven or eight coats and the best class of drafting pencils generally requires ten to twelve coats. Even though a large number of coats is required for a high-grade finish, the resultant film thickness generally does not exceed 0.0035 in. In many cases where a special color scheme is desired, particularly on the pencil ends, a dipping process is used. This may involve three or four extra operations, depending upon the number of colors used. Specialized automatic machinery is generally used for this purpose.

Although a pencil is relatively inexpensive, and although it is designed for destruction, a high-quality pencil is provided with as fine a finish as any available commercial item. Pencil finishes must be smooth, uniform, flexible, nonbrittle, and must have the property of adhesion to wax-impregnated wood. It must not be abrasive, in order that knives and sharpeners may retain their sharp edges over long periods of time, and the finish must not flake off or chip when the pencil is sharpened. It must also maintain an intact surface during the imprinting operation which will shortly be described. As may be suspected, very few manufacturers have been able to provide satisfactory finishing materials. In every case, suitable lacquers, synthetic enamels, etc., have required long periods of research and development.

As soon as the final coat of finishing material has been applied the pencils are put through an operation called "heading." This is generally done on a piece of mechanical equipment provided with abrasive drums and extremely sharp circular knives which abrade and cut away both ends of the pencils so that they eventually emerge nicely squared and smoothed. At this point in the process the pencil is complete except for decoration and undergoes further inspection which removes any defective pencils which may have escaped in preliminary inspections. In addition, finish imperfections are causes for rejection.

STAMPING

The majority of pencils receive some sort of imprint. In this operation the pencil is fed through a machine provided with an electrically heated die and a mechanism for feeding foil of various types. The foil used may vary from a relatively inex-

pensive aluminum base to a high-grade solid gold. The method is quite generally used in many industries. Although the largest percentage of pencils are stamped with the maker's name, model number, and type name, many are imprinted on special order for customers. Generally, these special pencils are imprinted with the customer's name and in some cases may also be provided with some advertising slogan.

Still other pencils are provided without any imprint whatsoever and are supplied to jobbers who imprint them for their own customers. Ordinarily, this type of imprint is done with ink stamping equipment rather than the standard method used in most pencil plants.

CAPPING AND PLUGGING

The ferrule and eraser are assembled on the pencils at this point and can be affixed on single-operation units or on combination machines. Caps made from plastics may be fastened with some type of adhesive. Brass ferrules, or caps, are forced onto one end of the pencil after a shoulder has been provided by cutting or forming and are held in position by forcing a series of prick punches to indent the metal and press the resulting prongs into the wood. After capping, the eraser, or plug, is inserted and this may also be held in place by pricking or by some suitable adhesive. A plate illustrating the various decorations and accessories together with an assembled pencil is provided in Fig. 5.

Immediately following these operations a final inspection is made, and in this case the pencils are examined for imperfect caps and plugs, finish damage, and proper location and affixing of the caps and plugs. For instance, the caps must be accurately placed both as to alignment and to position on the pencil. A variation exceeding plus or minus 0.005 in. between the edge of the cap and the pencil shoulder is cause for rejection. Similarly, a plug which is misshapen or of incorrect length or which is not properly located in the cap will be subject to rejection.

PACKING

Many varieties of packaging are used in the industry. Ordinarily, we may use a sleeve-type box, a paper sleeve and corru-

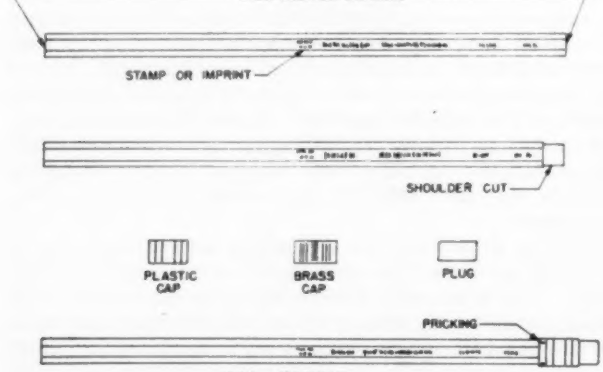

FIG. 5 PENCIL DECORATION AND ASSEMBLY

gated separator, standard boxes and covers, display cards, and the well-known pencil box. Most of the larger companies provide pencils and packages in variations running literally into the hundreds. This alone is one basic reason for the difficulty in using purely straight-line production methods.

CONCLUSION

We believe that sober thought will force us to conclude that the pencil industry is far ahead of other woodworking establishments in the matter of accuracy. This strict adherence to dimensions has been forced upon us for the same reason that it has been embraced by machine-part manufacturers and assemblers, namely, to enable us to make use of better and less expensive methods of mass production.

We also believe that a fair estimate of the work and precision involved will compel us to conclude that the average pencil provides a remarkable value at an amazingly low cost. In order to appreciate fully the value of a common ordinary lead pencil in our present civilization, we need only imagine what it would be like to suddenly be deprived of its use.

A Plea for Higher Standards in the Engineering Profession

(*Continued from page 934*)

liberal education in itself. The human contacts made, the opportunities for self-expression, the urge to original thought, which are an inevitable concomitant of broader intercourse with one's fellow men, constitute rich returns on the effort invested. As in most of the affairs in life, you get far more than you give, however great your contribution.

There is another sound reason for broadening the basis of an engineering education, however. The field of mechanical engineering has been tremendously expanded during the past two decades. The developments of the war period alone would probably justify the addition of two semesters of junior or senior work in engineering to the technical curriculum. It is no accident that those of us who received our engineering degrees 15 to 30 years ago find ourselves somewhat tongue-tied when confronted with the theory of atomic fission, with the broad array of new materials, with electronics, which latter is rapidly becoming the handmaiden of mechanical as well as electrical engineering, or of the new techniques of metallurgy and heat-treatment, with statistical methods of quality control, or of a host of other developments which were unknown a decade or two ago. If the mechanical engineer of the future is to be anything more than a narrow specialist, he is going to have to cram more material into his cranium than can possibly be done in the short space of a four-year college course. It is not my concept of the engineer's objective that he should go on knowing more and more about less and less, until finally he knows everything about nothing. Unless we are to have a completely functionalized society, the best engineer as a rule will be the broadest one.

We are on the threshold of an era of great scientific advancement, which, in the judgment of many, will generate a host of new industries and to such an extent transform our daily lives that one day the techniques of 1946 will seem as crude and outworn as those of the nineteenth century seem to us. If mechanical engineers are to meet the challenge of research and discovery, they will require the best of preparation. There never was a more timely moment in history to raise the standards of our profession or to take steps to hold them high. Professor Slichter of Harvard recently pointed out that physicists, chemists, engineers, and metallurgists are increasing in numbers from ten to fourteen times as fast as the gainfully employed, that expenditures on industrial research were nine times as large in 1939 as in 1920. Under these conditions, both the competence and the economic status of our profession will be enhanced by an increasing emphasis by this Society on quality rather than quantity. And that, gentlemen, is what we should stand for.

SCIENCE, TECHNOLOGY, *and* MAN

By P. Le ROLLAND

DIRECTOR OF TECHNICAL TRAINING, MINISTRY OF NATIONAL EDUCATION, PARIS, FRANCE

FOR men of thought and action, our time is tremendously full of potent but, alas, only too often, contradictory emotions. Ours is an amazing and admirable time, but it is also a profoundly troubled, wanton, and almost monstrous time.

In the glaring light of stupendous discoveries, we witness spectacles which overwhelm the wildest imagination, filling the most skeptical minds with a sense of strength, power, and beauty.

But at the same time we are disturbed by the social turmoil amidst which men are toiling, and the the futile and disorderly agitation of their daily life, so remote from genuine happiness for which they are yearning.

This paradoxical contrast, so characteristic of modern civilization, between the misery of man and the innumerable pledges of happiness offered by science, could not fail to challenge the fellowship of engineers throughout the world. And since you are men of thought as well as of action, you undertook to tackle at this International Congress the great problem, the only real problem of our time, namely, the task of bringing into line, for the sake of happiness, the moral, economic, and social order with the scientific and technical standards set by progress.

It will be the honor of this Congress to have faced this problem with determination, to have defined its terms with courage and clarity, to have worked out suggestions full of magnificent possibilities.

I do not propose to analyze your conclusions. But before we part, I am sure, regretfully, I wish to pay a tribute to the faith and enthusiasm which inspired your labors and the leading role which can and should be played by engineers in a crusade for the happiness of peoples.

It is a fact that within a few score years the creative will of man, with the aid of the powerful means placed at its disposal by science, has changed the face of the earth and the conditions of life more fundamentally than the thousands of years of its long history.

It is also a fact that all men believe today, both with fear and hope, in the immense potentialities of science. At a time when an aircraft crosses the Atlantic in a few hours, and the voice in a few thousandths of a second, science can only appear as a fantastically powerful and indomitable force, incapable of recoiling, advancing relentlessly toward new achievements, each more amazing than the other.

At a time when atomic disintegration opens up so many alarming prospects, while it raises so many new hopes, we can hardly control our imagination in its flight toward almost infinite possibilities.

Do we live in a "mechanical century," a "plastic age?" Are we about to enter an "atomic era?" Our time is so crowded with new creations that we are hardly able to describe it with an appropriate phrase. We can only say that it is a time of endless surprises, of unlimited transformations in which the most daring dreams have been overreached by stark reality.

And so men believe in the boundless power of science; but while most of them unreservedly admire its practical applications, others take the opposite stand and declare themselves hostile to technical progress and creative science.

Science, they claim, the pride of man, is at the same time the cause of his troubles and the source of his misery, for it drives him to satisfy new craving to the detriment of his peace of mind, his real happiness, and true culture.

With every material advancement, modern evolution brings a corresponding progress in despair, said the English writer Hilaire Belloc. René Boylesve wrote, "To my mind, the world, one day, has lost its way. It was the day when the infernal genius of science applied to matter started its career. . . . That day marked the decline of mind. Progress, if it exists, consists in the cultivation of the mind, but mind applied to matter, a process which, everybody agrees, commits the world to progress to the extent of turning this preposterous idea into a mystical belief, commences a cursed era which leads to the decline of intelligence and the misery of man."

It may be said that this onslaught is directed against technology, not against science, which, with the arts and letters, is the joy of human mind.

But it is our duty to affirm that science and its technical application are inseparable and constitute a single and selfsame reality. To attempt to separate one from the other would amount to trying to separate thought from action. It would also prove a logical impossibility, for the whole history of human ideas demonstrates that science and technology have always been closely associated.

"Science is a great achievement," wrote Montaigne, adding immediately, "and it is a marvelously serviceable tool."

It is true that the lofty speculations of science open up wide avenues to thought and overreach philosophy itself. It is true also that technology is more directly concerned in supplying man with more powerful means of controlling matter, thus being the driving power of industry and the source of wealth and prosperity of nations.

But despite this duality, science and technology constantly support one another in a sort of interpenetration so closely knit that it is impossible to tell where one ends and the other begins.

Technology without science and the light of its great principles would be but a disconnected series of empirical recipes. Technology, on the other hand, points out to science the way to reality, stimulates its efforts by calling upon it to solve new problems, and prevents it from losing itself in abstract speculation.

The means of Faraday, Ampère, and Gramme can no more be separated from one another than can those of Maxwell, Hertz, and Marconi, or those of Watt and Carnot. Mathematicians, physicists, or technicians, they are all entitled to an equal share of our admiration and gratitude. If technology must be blamed for the misery of man, speculative science, so closely linked with technology, must claim its share of responsibility in the chaos and disarray of the times.

But in point of fact, neither is prepared to shoulder this responsibility. For the truth of the matter is that the roots of the confusion and disorder of modern societies lie not in industrial progress, but in the lack of adaptation of the economic and social structure to scientific and technical achievements. We must realize the inevitable nature of progress. If technical progress leaps forward so rapidly, it is not because men like you, who are its loyal servants, are in constant search of new material satisfactions, but because, like the scientists, they are urged by

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the noble and irresistible craving for an ever deeper and more exhaustive knowledge of their universe. The continuity of progress is the very movement of the human mind. This is why it is impossible to stop it or even to slow it down. And its very relentlessness enables us to tell its detractors that it is pointless and futile to try to charge it with responsibility for the present disorder.

But it is our duty to ask ourselves whether science has contributed toward improving the lot of man.

On the whole, it is indisputable that science has increased the sum total of happiness; that it has had beneficial cultural effects by liberating man from drudgery; and that it has alleviated human misery.

Who would dare to claim at present that he would like to see the return of slavery and human sacrifices, or even of candlelight, and stagecoach travel?

For centuries human progress has followed technical progress, as if the admirable principle of Carnot, which ascribes a well-defined sense of evolution to the natural phenomena of the physical world, could be applied to human progress, and as if, in consequence, science must necessarily contribute toward the fulfillment of the individual within the social framework, toward the enrichment of his mind, and be a definite source of joy, felicity, and hope.

Yet, the spectacle of modern life fills us with anxiety. Agitation, turmoil, incoherence seem to have become the conditions of life of most people, many of whom seem unable to nurture their minds except with sudden changes and constantly renewed excitement. People can no longer stand duration. Their movements are regulated in definite fractions of time; they are urged by the railway timetable, the telephone, and the mail, those tyrants of modern life. Free time is dwindling; contemplative leisure no longer exists; and we have lost that exquisite sense of peace and restfulness of soul so essential to foster creative thought. Men of action who should think before acting, admit that they no longer have time for reflection. At a time when the machine should be a docile slave creative of ample leisure, man is crushed by the machine and the matter which he thought he had mastered.

Nor does this senseless agitation follow definite rules or eventuate in a normal social order. Imagine for a moment that an alien but intelligent being has landed upon earth from another planet. What a strange spectacle would be offered to his eyes! He would see, in most countries, men toil, build, operate, and carry out technical works; but at the same time he would see that all this is done, more often than not, haphazardly and with total disregard of the needs of others.

There seems to be no real agreement between men of the same country with regard to a rational use to be made of its natural resources; on the contrary, there is but a series of divergent and uncoordinated efforts, with the result that the yield is indifferent. There are a few machines in the fields, but how many extensive stretches are left lying fallow! How much unnecessary toil! How many machines and hands are employed exclusively in wreaking destruction and death! And what a strange distribution of the few riches, so painfully gathered! Those who honor their country by their intellectual and social merit, those who render most valuable services benefit but little, while mediocre and useless people profit to a much larger extent.

Men live in sumptuous dwellings while others die in slums. Destitution rubs shoulders with opulence, and only too often mere chance is master of human lot.

While it is true that science and the arts remain disinterested, in the political and social sphere petty personal interests and greed are too often the only motives of man. In the international field we see the same lack of agreement and organization. Nations confine themselves in perilous and indefensible selfishness, and peoples live in anxiety under constant threat of new catastrophies, the origin and meaning of which they are unable to grasp.

Resources are badly distributed and international trade is carried on at random. Men in the various countries come in contact only through acts of war or commerce which breed hatred, contempt, and distrust. There is no real friendship between men on earth.

The imaginary being is baffled by so much folly in the midst of so much potential happiness. Yet, if only men knew how to use their slaves, the machines, if only they had the will to shake off their new servitude. . . . . .

Scientific progress, which was to multiply wealth, reduce the toil of man, and become an essential instrument of their liberation, has been instead a source of disorder and misery by creating new needs, to satisfy which we exhaust ourselves in futile efforts. This amounts to saying that we have failed to adapt ourselves to the relentless pace of progress and have been unable to find ways and means of availing ourselves of progress for purposes of culture, harmony, and happiness.

The time has come to consider these essential problems, to realize fully the fundamental significance of the technical revolution we are experiencing, to understand the potency and the peril of economic causes.

You are fully aware of these things. Your Congress has placed before the world the great human problem of modern times: How to establish the indispensable and harmonious balance between the economic and the social structure, still rudimentary because of the persisting selfishness of men and peoples, and technical achievement wrought by science, that is, by human intelligence.

Such an equilibrium would bring in its wake the real modern "technical" civilization which we yearn for, and which, instead of crushing man, would offer the basis of happier and richer life as well as a source of new art.

We are convinced there is nothing utopian about the happiness of nations and that this happiness will become a reality if and when people have made up their minds that it must.

At any rate, our intelligence refuses to accept the notion that the great problem of modern humanism cannot be solved as soon as men of good will, infinitely more numerous and close to each other than is generally believed, have the will to solve it. This solution must lead to social justice and peace among men based upon absolute respect for individual freedom and human dignity.

For the fulfillment of the personality of each man is obviously an essential condition of true social equilibrium.

You are at the very core of the problem, and this is the real meaning and the value of your Congress. For, from whatever angle we approach it, be it modernization, scientific management, production, or distribution of raw materials or energy, it is the engineer, the technician, who must determine the technical elements which control economic and social problems.

This is why, while our technical role becomes more important every day, our social role is steadily growing. The engineer stands at a crossroads. His credit in the eyes of other men is that whichever road he chooses to follow, he is guided by his particular, scientific, technical, and social ideal. Moreover, along any road he pursues an ideal of peace.

It is this ideal that brought you here from your respective lands to explore and light up the road toward the future, to attempt to open up new and bright human perspectives.

Your experiences have been confronted, one with the other, and your ideas have got nearer or have merged together, for the emergency in the throes of which humanity is writhing is general and affects all the countries of the world.

(*Continued on page 967*)

POSTCOLLEGIATE ENGINEERING EDUCATION

Curriculum Developed by the General Electric Company for Specialized Training of Engineers

By K. B. McEACHRON, JR.

CHEMICAL DEPARTMENT, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

INTRODUCTION

When the General Electric Company was formed there were no electrical engineers available to test, install, service, or even operate the electrical equipment which the company manufactured. College programs were largely devoted to instruction in civil and mechanical engineering. What electrical courses were given were considered a part of the mechanical-engineering curriculum. In addition to pioneering in the manufacture of electrical equipment, it was also necessary therefore for the company to pioneer in postcollegiate education which would augment the meager training in the electrical-engineering field which the colleges were then able to give. The importance of engineering education to the success of the electrical industry was thus emphasized in the very beginning.

Since this early period, the responsibility of industry for supporting and extending such education has been increasingly recognized. Some companies established their own undergraduate educational programs. In some instances these are still in existence and have been given degree-granting powers. For a brief period in the late 1920's the General Electric Company also experimented with undergraduate education. However, the advantages in selecting college graduates from hundreds of different educational institutions soon led the company to abandon any plan to compete with the colleges in undergraduate programs. Since that time the company has concentrated entirely upon postcollegiate education and engineering apprenticeship which we believe industry is most competent to provide.

EDUCATIONAL METHODS AND PHILOSOPHY

In the early years of the electrical industry there were no precedents to govern the plans for postcollegiate education. Furthermore, there were only a very few persons who were qualified to give classroom instruction. The natural result was that most of the training was obtained by actually testing and experimenting with the finished products. This emphasis on "learning by doing" was largely one of expediency. The benefits, however, from this realistic educational method were so great that it has remained one of the primary emphases in all the educational programs of the company.

The invention of the electric light and the development of central-station systems created a demand for electrical equipment. The cost and economy of such equipment was of minor concern. As the industry grew, however, and competition began to be keen, the efficiency and initial cost became significant. Where it had been sufficient earlier to produce equipment that would operate, it was now also necessary that the equipment be economical in operation. It was seldom possible to make slight changes in existing designs to accomplish these results, and it more often required fundamental analysis of the factors involved. Only a few outstanding men, such as Steinmetz, were able to achieve satisfactory solutions to complicated engineering problems, and the industry largely depended upon such men for technical guidance.

In the early 1920's the dependence of industry upon these few outstanding men and the lack of qualified successors were matters of serious concern. Most design engineers were relying on handbook information and were incapable of extending their theory beyond that of such references. Recognizing the limitations which such a practice forced upon the design of electrical equipment, the company injected into the educational program a strong emphasis on thorough understanding of the fundamental principles of physics and engineering.

The pressure upon the colleges to produce full-fledged engineers upon graduation made it necessary for them to include many specialized courses and to underemphasize the training in fundamentals. Because of the diversity of engineering activities within the company and the comprehensive postcollegiate educational system we were and are primarily interested in college graduates who have a thorough understanding of the fundamental principles of engineering rather than specialized knowledge in any one field. The emphasis upon such fundamentals therefore continues to be of great importance in all our educational work.

The third important emphasis is the degree of responsibility which young college graduates are given from the beginning. Although this emphasis is closely related to the first, learning by doing, our educational programs would soon become sterile and lifeless were it not that young men who have been with the company only a few years are given complete responsibility for the policies and organization of the educational activities. Although such young men naturally do not have the background that certain phases of the work require, they are encouraged to call upon others in the company for assistance and guidance. No one, however, will make decisions for these young men. The enthusiasm which they therefore bring to such work is high. They have only a year or two in which to contribute their best ideas to the supervision and administration of the classes and training, and they are naturally eager to make the maximum improvement possible during the period of their responsibility. Supervision thus becomes a creative opportunity for each man to take the material and training which he received the year before, revise and improve it, and pass it on.

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ENGINEERING-TRAINING PROGRAMS

The "Test" Program. The earliest educational activity which the company organized was the Test. As the name implies, this program consists entirely of practical experience in the testing of electrical and mechanical equipment prior to shipment to the customer. Young engineers are therefore given an opportunity to examine critically and carefully the products which the company manufactures. The test engineer makes the various tests which are required to assure satisfactory future performance. He discusses with the design engineer the success or failure of given equipment to pass such tests and obtains an accurate picture of the high standards which such equipment must meet. Although much of his time is devoted to making electrical connections and other manual work, his knowledge of engineering and his ability to apply that knowledge are tried almost daily.

To acquaint the young engineer with the many types of equipment which the company manufactures and the diverse opportunities available to him, he is assigned to several testing sections in rotation, spending approximately three months in each. During these brief assignments he usually has an opportunity to advance from the task of helping a more experienced man in the early weeks to complete responsibility for testing given pieces of equipment in the latter weeks of such an assignment. Such progress even in so short a period gives him a sense of accomplishment and an opportunity for his superiors to judge his performance. His experience in the testing program will generally not be confined to any one factory but he will probably be assigned to at least three different works during the program.

The supervision of the test program is also obtained from the ranks of young engineers who have themselves only recently completed it. To each testing division there is assigned one young man as head. He is assisted by others, depending upon the size of the section, who have completed a test assignment in that section. These assistants are given a preferential rate of pay in recognition of their superior ability and their willingness to remain in a section where they have previously completed an assignment. Thus early in his engineering career the young engineer has an opportunity to achieve a position of leadership and to obtain actual experience in the handling of men.

More than 18,000 engineers have completed this program, spending an average of one year obtaining firsthand knowledge of the operation and performance of electrical and mechanical equipment. The young engineer who is employed on the test program is not obligated to remain with the company at its conclusion, nor is the company obligated to retain him. A majority of these men are still with the company and its affiliates. A large number have become interested in public utilities and other customers during their testing work and they have been given positions of responsibility in these organizations. Still others have returned to universities and colleges as members of the faculty with a better knowledge of industry and its need for engineering education.

The value which we place on the testing program is evident from the fact that it has always been the basic foundation for all the more advanced technical programs. Not only does it offer the young engineer an opportunity to adjust himself to industry, but it also gives industry a chance to evaluate his abilities, to place him in the type of work for which he is best fitted, and to offer him the further training which he can best utilize.

From the Test, some engineers enter the commercial and manufacturing fields and receive special training to acquaint them with the problems and operations of these groups. However, the great majority are interested in design and development and remain in the more technical fields. It is therefore the training given these men with which the balance of this paper is concerned.

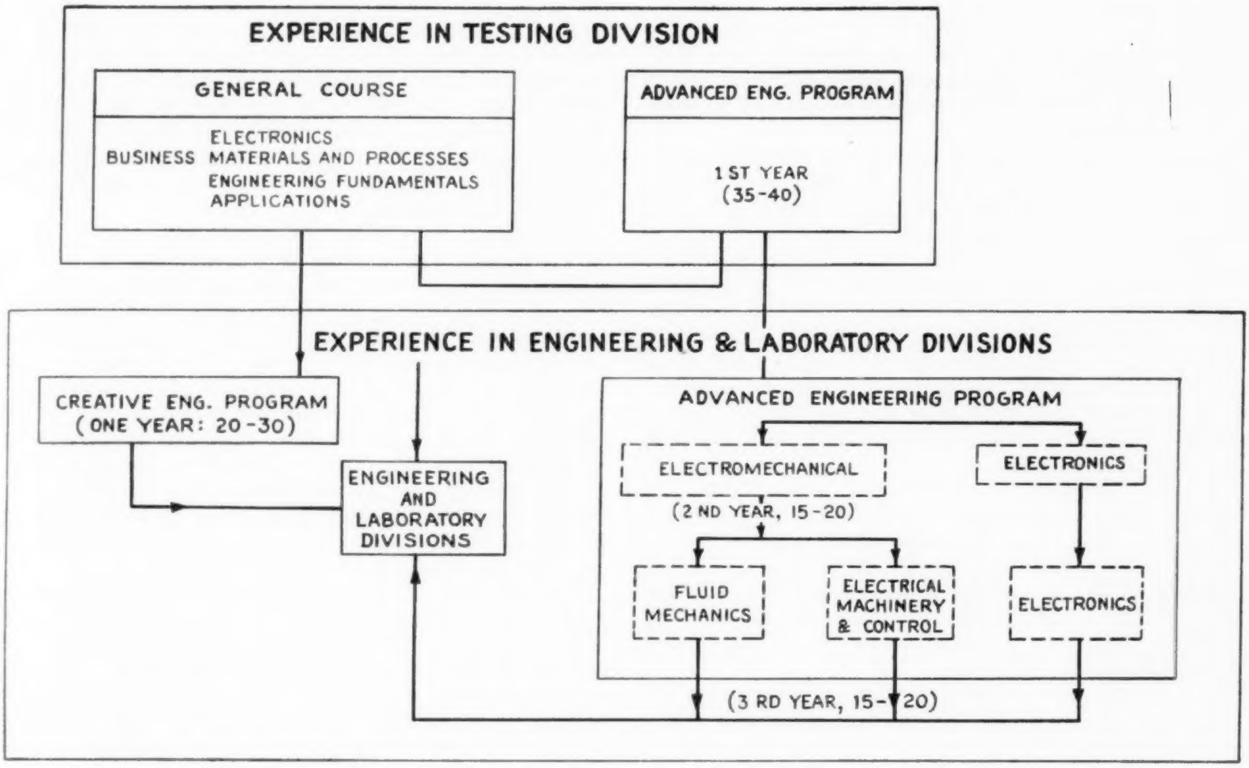
General Course. From a series of lectures first given in 1928, to acquaint young test engineers with applications of electrical equipment in the industrial, central-station, and transportation fields, grew the present General Course. From the beginning all college graduates and others deemed qualified to handle the work have been admitted without examination. Very few test engineers have failed to take advantage of this educational opportunity since the courses were first made available. In its present form the General Course consists of five divisions; one business and four engineering. Each division is given for a two-hour period once a week in the late afternoon or early evening. The amount of outside preparation required varies from one hour in the Business Division to six or eight in some of the more intensive engineering divisions.

The first General Course classes contained the type of material now given in the Application Division. Although this division has been largely confined to the study of the application of motors, generators, and controls in the transportation, industrial, and central-station fields, the subject material is being extended to include similar applications in all other fields of interest to the company at large. This division has been particularly valuable to young engineers who are preparing to enter the commercial field in the district and general office selling organization of the company.

In the Materials and Processes Division the engineer is acquainted with other materials and manufacturing processes which are available for the manufacture of the products which he designs. The characteristics of such materials, their changes with temperature, mechanical working, shock, and other external treatments are quite completely described. The effect of changes in chemical composition on the structure of metals and their characteristics is given much attention. New materials such as plastics are examined and studied as quickly as they become of importance to the industry. New processes of manufacture are described and their possibilities outlined. This division has been in existence for many years and its value is indicated by the high percentage of older engineers and designers who usually make up the enrollment.

In 1942 the requirements of industry in the high-frequency electronics field were so severe that the training of a large number of electrical engineers in the fundamentals of electronics was absolutely essential. To meet this need the Electronics Division was established and prepared several hundred engineers for the design and development of radar and similar radio detection equipment. Although the enrollment in this division has naturally diminished greatly, the fundamental nature of the material makes it equally valuable for the training of young engineers in radio and television activities.

During the war period particularly, young men entering industry seemed to lack a knowledge of the fundamental principles of engineering to such an extent that it handicapped their performance in the applications divisions of the General Course. The Engineering Fundamentals Division was organized in 1945, therefore, to prepare young men more completely for other divisions of the General Course and for the Advanced Engineering Program. Although principles of physics contained in this course are taken directly from college texts, the engineering problems are drawn from the practical experience of industry. In some instances this division will thus be a review of college physics work. In most cases, however, engineering students have been so concerned with specialized courses during the last year or two of college that the basic fundamental principles have been completely buried. It has been our intention to set the pace of this division halfway between that of a college



physics course and the Advanced Engineering Program. This division is basic to the other three engineering divisions, and engineers are encouraged to complete it before enrolling for others. However, the division is not at the present time a prerequisite for the others. It is too early yet to evaluate the significance of this new division, but reports from students and instructors alike indicate that it fills a very great need.

In the Business Division young engineers are acquainted with company organization and policy through a series of orientation lectures where the top officials of the company address the entire group. Following each general lecture, the division meets in small groups to review and discuss more specifically the prepared text material on organization. Also included in this division are lectures by design and sales engineers and manufacturing personnel describing the opportunities for future placement in their respective departments. These lectures give each test engineer an opportunity to become acquainted in a very specific way with the type of work in which each section of the company is engaged.

The adaptation of the General Course to current demands and new situations is well illustrated by the foregoing discussion. Each individual division is continually undergoing revision to make the training more valuable and applicable to the most recent developments. Each class makes use of prepared text material which is reviewed annually for possible changes and improvements. The instructors are carefully selected for their enthusiasm and knowledge of the subject and their ability to present this knowledge clearly and concisely. Very few instructors are selected for more than two or three years in succession in order to make the supervising opportunity available to as many persons as possible and to retain the natural enthusiasm which young men have for this responsibility.

Advanced Engineering Program. The direct result of the concern of the company in the early 1920's for the theoretical basis of its engineering work was the inauguration, in the fall of 1923, of the Advanced Engineering Program.[1]

The program was organized under the direction of R. E. Doherty and A. R. Stevenson, Jr., both of whom had been pupils of Dr. Steinmetz and Dr. Berg, and had caught from these men an appreciation of the fundamental principles of physics and engineering. This experience, plus a high degree of enthusiasm for the new program, was chiefly responsible for the early success of the program.

Since its founding the program has had two fundamental objectives: (1) The application of the fundamental principles of physics and engineering to the solution of actual engineering problems; and (2) the presentation of such solutions clearly and concisely so that the results might be easily understood and utilized. Although many changes have occurred in the nature of the instruction given, these objectives have remained.

Selection for the program from the hundreds of test engineers employed each year by the company is based upon several factors. Because of the intensive nature of the training, individual enthusiasm for the program is essential and of most importance. Those who desire to undertake such training are given an entrance examination which consists of simple applications of the principles of physics. Although the results of this examination are of major importance, other factors such as college record, faculty recommendations, experience on test, and interview rating are considered, particularly in those cases where the results of the examination are not entirely conclusive. Each year between 30 and 40 men are so selected to begin the first-year class.

The entire Advanced Engineering Program comprises three years beginning with the A Class and continuing with the B and C Classes. Each class is given for half a day once a week during regular working schedules. Men of the first-year class

[1] From 1923 to 1942 this program was known as "The Advanced Course in Engineering."

spend the balance of the normal work week in the testing division, while those in the B and C Classes spend such time in engineering divisions. In addition to the time spent in class, outside preparation of approximately twenty-hours per week is required for the A Class and from ten to fifteen hours per week in the B and C Classes.

Included in the A Class is material on thermodynamics, electricity and magnetism, elasticity, dynamics, heat transfer, and fluid flow. Not all those selected for the class have had differential equations in college and therefore this branch of mathematics is reviewed and extended to include partial differential equations. Only that mathematics directly applicable to the solution of engineering problems is covered. In addition to technical lectures and problems studied, the members of the A Class are acquainted with the company organization and policies by company officials and engineering executives. These orientation lectures augment the experience which these men are obtaining in various sections of the company during their regular test assignments.

Near the conclusion of the A Class, selections for B and C Classes are made on the basis of interest and demonstrated performance. Prior to such selections, members of the class are invited to luncheon in small groups where they have an opportunity to meet key personnel in the company and to indicate their interest in the various phases of the business. Approximately half of those admitted to the A Class continue with the more advanced sections.

Those who continue with the Advanced Engineering Program are transferred from the testing division to a general pay roll from which they are assigned for periods of from three to six months to engineering laboratories and design divisions. Their experience is further broadened and they become better acquainted with the personnel in the engineering sections. During this period also a further evaluation of each man's ability is made and matched with opportunities available in the company.

The classroom work during the B Class is divided into two sections, i.e., electromechanical and electronics, and in the C Class into three sections, i.e., electrical, fluid mechanics, and electronics. The subjects of electricity and magnetism, elasticity, and fluid dynamics are enlarged upon in the Electromechanical Section in preparation for the C Class. The Electronics B Section is devoted to a study of fields and waves as related to communications systems.

The Electrical Section of the C Class includes study of electrical machinery and control of all types. Electronic circuits and the extension of Maxwell's equations to moving systems are contained in the Electronics C Class.

The Fluid Mechanics C Class has only recently been organized. During the war the development of the aircraft gas turbine, the supercharger, and the other equipment dependent upon high velocity flow required training in fluid-dynamics theory beyond that being given. The Fluid Mechanics Section of the C Class was immediately organized to provide such advanced training. During its two years of operation, it has made signal contributions to the readily available theory in this field. Translations from German texts and technical literature were the basis for the original work although more recently extensions beyond this material have been made.

With the exception of a brief period during the war, the program has been in continuous operation since its organization. More than 700 men have been graduated from this program, and most of them are still with the company, forming the nucleus for the solution of the company's most difficult technical problems. When the war began we thus had a group of exceptionally well-trained men who had not been educated narrowly in only a single specialty but who had been rotated from one engineering section to another and thus were in the habit of tackling new projects. These men were transferred directly from refrigeration, air conditioning, and other peacetime jobs and formed the technical foundation of greatly expanded divisions, such as, radio, superchargers, and armament control. During the reconversion period the value of such versatile training is again apparent when engineers thus prepared are readily adjusting themselves to the important peace time tasks in engineering.

A description of the Advanced Engineering Program would be incomplete without emphasizing the flexibility of the curriculum and the training for leadership which it provides. The policy of delegating maximum responsibility to the young men themselves has been extended to the technical supervision and administration of the program. The instructors of all the classes are themselves recent graduates of the classes which they supervise. These men are encouraged to revise their respective classes to include more up-to-date applications of fundamental principles and to improve teaching methods. Continual revision of the curriculum thus becomes almost automatic and no class can to any great extent lag behind progress in the art. In most instances each year finds the classroom instruction considerably in advance of the industry.

Although the secrecy which has surrounded the first applications of nuclear energy prevented the inclusion of such material in the program during the war, plans are under way to extend the present third-year classes to cover this field. For some months the men who will be responsible for the technical supervision in this field have been attending seminars and conferences with outstanding authorities in the field in preparation for this new extension of the technical program.

Creative Engineering Program.[2] When the Advanced Engineering Program was first organized, it was the hope of its founders that in addition to emphasizing the importance of fundamentals in analysis, it might also improve the ability of engineers to create new and ingenious designs. Within a few years the difficulty of combining these two objectives in a single program led to the present concentration on the analytical solution of engineering problems. Less attention was therefore devoted to the creative aspect of engineering design. However, as the graduates of the Advanced Engineering Program began to fill the need for engineers capable of fundamental analyses, the need for engineers with creative ability became more apparent.

In 1937 the Creative Engineering Program,[3] under the direction of A. R. Stevenson, Jr., who had played such an important part in the Advanced Engineering Program, was organized to discover and develop intuitive abilities in those engineers who possess them. Although some of the approach to the problem of selection and training of such engineers is similar to that in the Advanced Engineering Program, there are several aspects in which it is basically unique.

While college records were useful in the selection of analytical engineers, such records were not only unreliable but often misleading in the selection of creative men. In some cases the demands of the college program in terms of analytical performance actually reduced or destroyed much of the creative tendencies which the prospective engineer had as a high-school graduate. Few colleges prior to the war offered any real opportunity for creative engineers to demonstrate their ability. The press of heavy schedules even forced the elimination of hobbies and other indicators of creative ability. As a

[2] A complete description of this program is contained in the article "Developing Creative Engineers," by J. F. Young, MECHANICAL ENGINEERING, vol. 67, 1945, pp. 843–846.

[3] From 1937 to 1942 this program was known as the "Mechanical Design Course."

result, much of the early selection of men for this program was based upon aptitudes and upon hobbies which were active during high school.

Present selection for the program is still strongly based upon the spare-time activities of the applicants and the evidence of ingenuity which can be obtained through interviews with well-established and proven creative designers. A prospective member of the program will be interviewed by several of these men, particularly when his background and interests are not conclusive with respect to his creative tendencies. This method of selection has the further advantage that the older creative engineers are directly and continually concerned with the program and feel in great measure responsible for the persons whom they have recommended for it.

Each year about 30 young engineers are selected for the one-year program from those who apply on the basis of interviews and records in the testing division. Although occasionally men with very short testing experience are selected, most engineers chosen have completed a year or more in this division. Most of them have also completed the Materials and Processes Section of the General Course. The testing experience affords additional opportunity to evaluate the creative abilities and interests of the young engineer.

Successful applicants are transferred from the testing division to a general pay roll from which they are assigned to engineering sections throughout the company. Such assignments are very carefully made, for this is the most important phase of the program. Each young creative engineer is apprenticed for successive periods of three to six months to outstanding creative engineers. During each assignment he develops an appreciation for the creative approach of his superior and integrates this experience with that which he has obtained on other similar assignments. The assignments given each engineer are gradually increased in responsibility so that he depends more and more upon himself as he gains experience. By contact with many different engineers he can develop his own method for creating new designs and new products.

In addition to this apprenticeship, classroom training is given during regular working hours for half a day each week. The fundamentals of engineering and their application to proposed designs is studied to insure that proposed changes or new designs are actually workable and possible of manufacture. Problems are assigned each week which require from ten to twelve hours of outside preparation and develop the young engineer's ability to translate his creative ideas into workable designs. The problem assignment during a portion of the year is devoted to a single design project of major proportions. Such a project approximates the work which the young engineer will be called upon to carry through when he completes the program.

Since 1937 more than 150 men have been graduated from the Creative Engineering Program. More than three fourths of these are still with the company in important engineering positions. The program has definitely proved its worth through the contributions which its graduates have made to the engineering leadership of the company.

TRAINING FOR LEADERSHIP

In the earlier period of development of the electrical industry, knowledge of the fundamental laws of physics and an ability to apply them to the solution of engineering problems was almost certain to guarantee a measure of success. As the industry has grown and more highly trained technical people have been made available by the colleges, the emphasis upon technical ability has become overshadowed by the importance of leadership and administrative ability. Today there are more persons available who can do an outstanding technical job in comparison with the number of those who have the ability to work through other people to attain given objectives.

Except in a very few sections, such as research or mathematical investigations, the ability to get things done is more dependent upon a proper understanding and utilization of the organization's structure than it is upon the technical skill of the individual. The college graduate must therefore recognize that whatever his own impression may be concerning the value of pure technical ability, industry does place considerable importance upon the ability to accomplish objectives through others. The law of supply and demand operates as positively to determine the success of a man in a career as it does to determine the sale of a product.

The company has recognized its dependence upon continuing capable leadership. Its entire educational system provides a unique type of training for leadership. From the moment the young engineer enters Test to the time he retires, he is encouraged to accept responsibility and to develop to the maximum his ability to guide and direct the activities of others. Much yet remains to be done, however, to emphasize in the mind of the young college graduate the importance of developing qualities of leadership.

The company's educational programs have been developed and extended continuously to increase the numbers of engineers receiving training and to enlarge their areas of understanding. Without education there can be no growth, and without growth of individuals there can be no progress. The degree to which each engineer can become adequately informed in engineering and management fields will determine not only the progress of one company or of one industry but of society as a whole.

Science, Technology, and Man

(Continued from page 962)

By your free discussions and the cordial exchange of ideas you have added to the bond which link men together. You will, I am sure, carry on with faith and certainty of success an action which our Congress has but started.

We are emerging from a long nightmare. The liberty and independence of peoples have been saved from the greatest peril of their history. But the world is still covered with wounds and steeped in tears, and nations seriously affected, like France, are only beginning to recover.

France, so cruelly tried in her soul and in her flesh, is happy and proud to have sheltered the beginning of an enterprise as beneficial to peace and as deeply human as yours.

Now that, completely free, she is raising her head to smile to friendly nations who never ceased to believe in her, I hope that you have found her true to her traditions of gentle kindness.

To the artisans of peace that you are, France wishes to proclaim her faith in the future of humanity.

What this future will be made of is a cause of anxious speculation. But even after so much suffering and at a time when heavy clouds pregnant with storm are darkening international skies, France proclaims her will of peace and her utter faith in the early advent of justice and concord among men and nations.

Despite the menaces of this hour, she is profoundly convinced that men, who, thanks to science and technology, have become so powerful as to be real masters of nature, will not fail to understand that the only way to attain real happiness is to work in trustful co-operation with all peoples for the happiness of all men on earth.

It is a message of peace and good will that, after welcoming you with joy, France wishes you to take back to your respective countries, a message which she accompanies with sentiments of confidence and true friendship.

COLLECTIVE BARGAINING *for* PROFESSIONAL EMPLOYEES

By RAYMOND L. FORSHAY

TENNESSEE VALLEY AUTHORITY, CHATTANOOGA, TENN.

DO we need collective bargaining for engineers? Do we need to sit down at the conference table with management and discuss the engineer's problems, such as our relationships with management and labor, our working conditions, and salaries?

NECESSITY FOR ENGINEERS TO ORGANIZE

Let us look at some actual conditions, not simply theoretical or hypothetical situations. Let us take the case of the field engineering force on a construction job in Illinois where the A.F. of L. building trades are fully organized. This past spring the management of the engineering firm was advised by representatives of a labor union that these engineering employees, part of whom were professional engineers, should be members of a certain A.F. of L. technicians' union which embraces such employees. The management apparently ignored the advice and failed to mention the incident to the employees affected. Some time later the union made a direct contact with the men, advising them to join their union. Upon refusal, an A.F. of L. picket line was established around the job and work was stopped for two months. After some jockeying by both sides, work was resumed but the union singled out two professional men and would not allow them entry to the project. The alternatives for these men seemed to be either to join the union or be forced out of their jobs. The only other recourse which they have under present labor laws is to form a collective-bargaining group with employees having mutual interests, unless they may seek refuge under the recently enacted Hobbs Bill.

There is also the case of the engineers in a public utility in Minnesota this past spring who were faced with the danger of absorption by an A.F. of L. union; the threat to a group of engineers in Arkansas on a large ordnance construction job last year; the fight at Curtiss-Wright at Columbus, Ohio, involving both the C.I.O. and A.F. of L. and a group of professional employees; the long pull at RCA's Camden, N. J., plant, where the Association of Professional Engineering Personnel negotiated a contract that was finally signed in February of this year; The Research and Engineering Professional Employees Association of Whiting, Ind., which has a contract with Standard Oil of Indiana, and many other cases all over the country, particularly on the West Coast.

All of these cases demanded immediate action. They could not wait while the Founder Societies tried to get the Wagner Act amended or figure out some other means of maintaining professional dignity. The need for action was immediate, and the engineers involved forged ahead with the guidance offered by the A.S.C.E. plan, negotiating contracts with their employers as independent associations, such contracts being written from the point of view of the professional employee with due regard for his standards of ethics and ideals of fair play.

Contributed by the Committee on Education and Training for the Industries and presented at the Fall Meeting, Boston, Mass., Sept. 30-Oct. 3, 1946, of The American Society of Mechanical Engineers.

WEST COAST ORGANIZATION OF ENGINEERS

In particular, the engineers on the West Coast have shown decided progress in developing working contracts governing the conditions of employment of professional engineering employees. Out there, in the large industrial plants, the engineers are concentrated in great numbers and labor organizations have sought to enfold them. The Southern California Professional Engineers' Association has been very successful in holding negotiations for collective-bargaining contracts on a professional level. The Association has a contract signed in March of this year covering professional engineering employees at the Douglas Aircraft Company plants at El Segundo and Santa Monica. It represents the professional engineering employees of the Los Angeles Department of Water and Power in matters concerning employee relations. It won an election contest from the C.I.O. by an overwhelming majority for certification as bargaining agent for engineering employees of the Southern California Gas Company.

Another active group on the West Coast is the Seattle Professional Engineering Employees Association, who, in August of this year, signed a contract as bargaining agent with Parker and Hill, consulting engineering firm of Seattle, and will represent the professional engineering employees of that firm employed in the State of Washington. This association is also negotiating with Boeing management for a contract covering engineers employed by that large aircraft manufacturer, after 81 per cent of the professional employees voting in an N.L.R.B. balloting in May, selected it as their bargaining agent. Other active groups in the coastal region are the Southwest Washington Association of Professional Engineering Employees and the Engineers Guild of Oregon.

COLLECTIVE-BARGAINING GROUP FIRST FORMED IN TENNESSEE

To the author's knowledge, the first of such type organizations began functioning late in 1943; it was the Tennessee Association of Professional Engineering Employees of which the author was one of a committee of three elected to organize and conduct its affairs. There was no question of choice for the engineers, it was either organize or be represented by the A.F. of L. T.A.P.E.E. was the first to try to establish the principle that a unit composed of professional employees was appropriate for the purposes of collective bargaining and could represent such employees in negotiations with management.

T.A.P.E.E.'s principal activity was during the construction stages of the atomic-bomb plant at Oak Ridge, Tenn., otherwise known as the Clinton Engineer Works. Signed collective-bargaining agreements were obtained from two contractors at the project, and the association became involved in a showdown contest with the International Federation of Technical Engineers, Architects and Draftsmen's Union, an A.F. of L. affiliate, for recognition as collective-bargaining representative for engineering employees of a third contractor who employed the largest engineering force on the project at the time. After almost a year and a half of hearings, charges, and counter-

charges, and a strike threat by the A.F. of L. union, W.L.B. handed down a decision ordering a "member only" contract for T.A.P.E.E. However, by that time, the construction work was essentially completed and a very large proportion of the engineering force had moved to other locations.

The main accomplishment of the proceedings in this case was that they pointed the way to a more definite determination of policy on the part of N.L.R.B. and W.L.B. toward recognizing the interests of the engineering employees.

ENGINEERS CAUGHT BETWEEN LABOR AND MANAGEMENT

Now, let us consider first some of the particular questions which are invariably asked when one speaks of organization for the professional men. For instance, "Why is there any need to organize?" Primarily as a defensive measure, because, since the National Labor Relations Act was passed, engineers have been quite frequently absorbed into heterogeneous groups, usually against their will but helpless to resist the tide. It is no longer a question of whether engineers want to be organized. We might wish to do it differently, perhaps through our Founder Societies or the National Society of Professional Engineers, but today's question is, "Do engineers wish to allow others to speak for them in negotiations with management?" William H. Davis, former chairman of the N.L.R.B., in a speech before the Metropolitan Section of A.S.C.E. in New York on November 15, 1944, pointed out that "professional workers are in a difficult position between management and production workers. The theory that their position is an impartial one finds little support in actual practice. Their functions are sometimes managerial, and N.L.R.B. has quite generally recognized that their ethical and economic outlook is so different from that of production workers as to make separate bargaining groups for them a logical arrangement."

On the positive side, aggressive organization by engineers is needed because of the large concentrations of their profession in present-day engineering organizations. In such cases it is practically impossible for management to know or to become acquainted with their problems, and they are not inclined to listen to the individual engineering employee, any more than to the individual tradesman. In these days management in large organizations has too many worries to bother with the rank and file of the engineers. Under such conditions the professional employees are justified in organizing to make their collective weight felt, both toward improvement of working conditions, and adequate compensation for the work they do.

Next, there is the question: "Are professional employees entitled under the Act to bargain collectively?" The answer to this question is a decided "Yes," as exemplified by the groups operating according to A.S.C.E.'s plan. However, there are certain limitations imposed by the Wagner Act, for example, upon those professional employees whose positions are determined to be confidential or supervisory. Mr. Davis reiterated this point in the speech mentioned, and further pointed out that even the supervisory employees may organize for collective bargaining if they wish.

If employees are in confidential positions they will come under the close scrutiny of the board to determine the degree and character of that relationship, and professional attainments have little weight in such considerations. Under the language of the Act, such employees may be considered as either an "employer"[1] or as an "employee," depending upon their examination of this "confidential" relationship. As an example, in referring to the design engineers of Chrysler Corporation,[2] the board found "nothing" peculiarly personal in the relationship between the company and its many hundred "engineers" even though the company had claimed they were "confidential" employees. Again, when Westinghouse Electric and Manufacturing Company sought to exclude time-study engineers and other employees from a unit because their work was of a confidential nature, the contention was dismissed because "the work performed by these employees does not relate directly to the problem of labor relations nor are they so identified with management that they should be denied the right to bargain collectively."[3]

However, if an employee is included in conferences concerning policy or labor relations, or has ready access to correspondence concerning such matters, so that his duties may be considered managerial, then he would properly be excluded from the bargaining unit. In general, where a number of rank, and, file engineers are working on production schedules, research projects, a construction job, or other form of engineering work, most of them can be assumed to be eligible for membership in a bargaining unit.

PROFESSIONAL EMPLOYEES WITH SUPERVISORY DUTIES

Professional employees who have "supervisory" duties are very likely to to be excluded from professional groups organized under the Act, but here again it depends upon the degree of supervision exercised by these professional employees and not just the existence of any supervisory functions. For example, in the contract which Stone and Webster signed with the I.F.T.E.A. and D.U. on May 27, 1946, in addition to the subprofessional and nonprofessional men, it provides that two top categories of men, who are professional and who have supervisory functions over the other men, shall be included in the unit; their qualifications require college degrees, plus three to five years of experience or the equivalent.

Influential engineers in the New York and Boston areas have been opposed to the idea of collective bargaining on the professional level, with the result, as exemplified by this case, that heterogeneous unions may represent the professional engineer in discussions with management covering salaries and conditions of employment.

The case of the Maryland Drydock Company[4] is of particular interest to engineers, for in it the Board recognized the relationship of employees working in a supervisory capacity as a link between management on the one hand and the production workers on the other. The Board points out that such employees are acting as "agent" for the employer and thus their acts are binding upon the employer whether in collective-bargaining procedures or otherwise. In this case the Board decided that "the interest of foremen lay predominantly with the management groups. . . the establishment of bargaining units composed of supervisors exercising substantial managerial authority will impede the processes of collective bargaining, disrupt established managerial and production techniques, and militate against effectuation of the policies of the Act." However, recent decisions by N.L.R.B. with respect to foremen's groups (for example, the Packard Motor Car Case) indicate a definite change of policy by the Board.

Also of particular interest to the engineering profession is the exclusion by the National Labor Relations Act of employees of the United States, or any state or subdivision thereof, to the right to bargain collectively. It is apparent that this seg-

[1] By definition in the Act "the term 'employer' includes any person acting in the interests of an employer, directly or indirectly," but excepts the U. S., states and their political subdivisions, persons subject to the Railway Labor Act, and labor organizations. On the other hand, "The term 'employee' shall include any employee . . ." except agricultural laborers and domestic servants.

[2] 1 N.L.R.B. 164; 169.

[3] Matter of Westinghouse Electric and Manufacturing Company (Louisville Ordnance Division), Case No. R-4711.

[4] 44 N.L.R.B. No. 31.

ment cannot benefit by the Act unless it is modified, except as such government bodies may voluntarily recognize the rights of these employees to bargain collectively. The fate of public employees is to a large degree tied to that of the professional groups employed by private employers.

DUTIES OF EMPLOYEES DETERMINE STATUS

Another question, and a very pertinent one, is "How do you define a professional employee unit?" Of prime importance is the view of the N.L.R.B., and it has quite definitely developed that, to the Board, it is the actual duties of the employees that determine their status. In most instances, the duties of a group of engineers are so related that their educational background and professional attainments are within a range which may be properly defined as a logical bargaining unit, but there may be exceptions, as, for example, in the case of Southern California Gas Company. In this particular case, the N.L.R.B. would not permit separation of the professional and subprofessional employees, holding that:

"A unit delineated upon the basis of the scholastic or (equivalent) history of individual employees rather than on the basis of their function, would in our opinion be unworkable and inappropriate for collective-bargaining purposes."

This necessitated some change in the make-up of the bargaining unit. The Southern California group then organized the subprofessional groups into a separate unit and a short time after the foregoing decision was made, the same Board recognized as an appropriate bargaining unit, a subprofessional group in the Douglas Aircraft plants. The subprofessional group, in turn, designated the professional group as its bargaining agent. In such exceptions it may be necessary for the professional-employee group to recognize the limitations imposed by the Act and to accept a compromise. Such cases serve to emphasize the fact that N.L.R.B. is not interpreting the Act to preserve the professional status of engineers, for the stated policy of the National Labor Relations Act is to "encourage the practice and procedure of collective bargaining by protecting the exercise by workers of full freedom of association, self-organization, and designation of representatives of their own choosing, for the purpose of negotiating the terms and conditions of their employment or other mutual aid or protection." It makes no mention of preserving the professional status! That is our own responsibility!

Mutuality of interest of a group, economic strength, history of the organization, and past functions in the interest of the employees are items which will come in for scrutiny by the Board in examination of a unit to determine its appropriateness for collective bargaining. While the N.L.R.B. has recognized the interests of the professional employees as being different from those of trades- and labor- or industrial-union groups, as indicated by the Shell Development Case[6] and others, nevertheless, the N.L.R.B. is not likely to redivide a group already formed on the basis of an academic degree or other consideration which it might determine as "arbitrary."

WHAT OF THE ENGINEER'S DIGNITY?

If it is assumed that there is some need for organization by professional men, we still have the question, "Isn't it beneath the dignity of engineers to bargain collectively?" In 1944, Scott B. Lilly, professor of civil engineering at Swarthmore College and a former director of A.S.C.E., put it this way. "The inherent difference between professional men and others is that the professional man undertakes to serve society... Thoughtful people are agreed that one of the most difficult questions that this country will face at the end of the war is the relation between management and labor. There is no group as well fitted as the engineer to bridge the gap between the employer and the employee. He understands the problems of both; he is accustomed to assuming the position of interpreter between the two groups and it would seem that he has a special obligation at this time to make his contribution by aiding in the settlement of this difficult problem. How can he better approach this problem than by attempting to solve it for his own group and solve it in a way that will result not only in the protection of the younger men of the profession, but in a way that will make a real contribution to the whole movement?"

In 1944, when Professor Lilly made the foregoing observation, other prominent engineers were accusing the young engineers of scuttling professional standards and attitude for transitory economic gains. They did not seem to realize that in his own defense and to maintain his professional status, the young engineer needed to act. Now, two and a half years later, let us observe how he has acted. Of the independent professional, engineering-employee-associations' contracts with which the author is familiar, the following provisions have generally been written in: In event of layoff, those employees who possess the greatest ability to perform the required work or to improve the efficiency of the engineering department shall receive first consideration, and where there is a question of choice between two employees of equal abilities, then seniority should determine the choice. As a contrast is cited the contract mentioned previously between Stone and Webster and I.F.T.E.A. and D.U. in which are these provisions:

"All decisions with respect to promotions shall be made by the employer. There shall be no promotions, however, to a higher classification within the bargaining group, while employees having greater seniority in the higher classification are on layoff.

"When a layoff takes place, top seniority will be accorded to not more than eight persons to be designated by the union from their elected officers and stewards. The employer will be kept furnished with a current list showing the persons designated."

There are many other differences in the contracts. In general, however, the contract by the union group follows the usual union setup, while the professional-engineering-association contract recognizes the responsibility of management to provide differentials in pay in recognition of merit and efficiency, and the determination of employee performance with respect to selection of those to be promoted, retained, or discharged.

PRINCIPLES OF COLLECTIVE BARGAINING

If engineers or other professional groups are to bargain collectively, there are certain factors which must be recognized as necessary for success:

1 There must be unity. Unity of purpose, with such purpose based upon the ethical and moral standards of the profession. Improvement of the economic position of the engineers is, of course, highly important, but it must not be allowed to overshadow the other factors which establish engineering as a profession. There must also be unity of action when purpose and aims have been agreed upon, and the course decided.

At the present time there is a divergency of thought as to the desirability of collective bargaining by professional employees, presumably motivated by a fear of the future of such bargaining groups. Such fears will prove groundless if the professional man continues true to his ethical standards. Professional groups have established in their constitutions statements against labor-union tactics, such as strikes or closed

(Continued from page 975)

[6] Matter of Shell Development Company, Inc., and International Federation of Architects, Engineers, Chemists, and Technicians (CIO) Case No. XX-R-552 (38 N.L.R.B. 92).

AIR INDUSTRIAL PLANNING *in the* POSTWAR PERIOD

By MAJ. GENERAL B. W. CHIDLAW[1] and BRIG. GENERAL E. W. RAWLINGS[2]

HEADQUARTERS, AIR MATERIEL COMMAND, WRIGHT FIELD, DAYTON, OHIO

More than 150 years ago this nation entered its first postwar period. Since that time this peaceful country has been compelled to undergo three major wars, three minor wars, and a number of military expeditions and special campaigns. During this span from the eighteenth to the twentieth century, great scientific, economic, and military advances have eliminated the barriers of time and space which once served to guarantee certain fortunate nations from the danger of hostile attack. Today therefore following World War II, or what historians might someday refer to as "The Great Air War," it becomes increasingly necessary for this country to plan its security consistent with the principles of our Government and with the challenging problems of the foreseeable future.

INDUSTRY AND THE POSTWAR AIR PROGRAM

In October, 1945, there was presented to the Senate Military Affairs Committee a comprehensive report covering the industrial aspects of the postwar air program. This report was submitted by the Air Co-Ordinating Committee, a governmental interdepartmental body consisting of the Assistant Secretary of War for Air, the Assistant Secretary of Navy for Air, the Assistant Secretary of State, the Assistant Secretary of Commerce, and the Chairman of the Civil Aeronautics Board. This report stresses the importance of industrial planning as a keystone to our national defense; emphasizes the co-responsibility of the Air Forces and industry in consummating planning programs; and shows the necessity for the understanding and support of representative groups of private citizens, such as this Society.

World War I, and to a great extent World War II, showed that our war production to be successful required the complete co-ordination and harmony of the Armed Forces and industry. During the peacetime years of the 1920's and 1930's, there had been a certain but unfortunately limited amount of industrial planning. Now in 1946 all parts of our Armed Forces are concerned with industrial planning; the Navy, Army Ordnance, Signal, and the other services, as well as the Army Air Force.

The phrase "industrial planning" means just what it says, namely, planning the industrial aspects of our preparedness program. Planning must be soundly conceived and comprehensive in scope. We should have constant planning as to what we will want, when we will want it, who is going to produce it, where it will be produced, and how it will be produced. The "what" and the "when" comprise the military side of the problem, while the "who," "where," and "how" comprise the industrial side of the effort. There will be the necessity of integrating industrial plans with military plans; the industrial plans must be kept abreast of military-program changes.

It should be pointed out that the atomic bomb, current developments in guided missiles, and other new weapons raise a number of questions about the part which conventional airplanes will play in the maintenance of air power. It is not believed that the present conception of an air force is radically altered. This conception includes all of the developments which are taking place in new methods of propulsion, in the use of electronic devices, and in the attainment of supersonic speeds. The necessity for constant revisions in planning to take these new factors into account as rapidly as possible, although self-evident, is strongly emphasized.

Air industrial planning is a plan of peacetime industrial preparedness that will insure our ability to expand rapidly air materiel production. In event of an emergency, industrial planning buys valuable time, precious time, perhaps even priceless time.

AIRCRAFT PRODUCTION IN WORLD WAR II

Fig. 1 is a comprehensive time chart showing aircraft production in World War II. The ordinate is millions of pounds of airframe weight, for it is apparent that aggregate poundage is a much more reliable and realistic measure of production than plane units; the abscissa is years divided into quarters.

A gradual rise in aircraft production is evident through June, 1940, when, with the French Air Force destroyed by the Luftwaffe and the battle of Britain expected momentarily, President Roosevelt announced his 50,000 Plane Program. This was a dramatic and astronomical figure, but, unfortunately, it bore no relation to potential orders of specific planes or to present or projected capacity of the manufacturing aircraft industry. You will note the date of this 50,000 Plane Program has been flagged as the "go ahead," while our actual entrance into the war was nearly $1^1/_2$ years away. Production

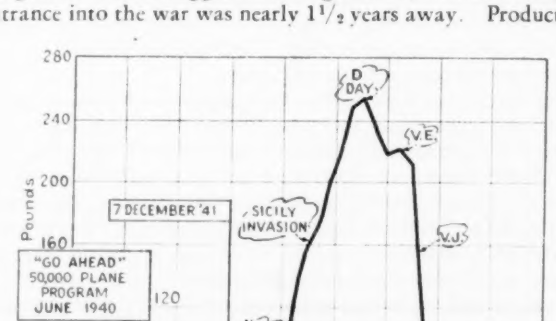


FIG. 1 AIRCRAFT PRODUCTION IN WORLD WAR II
(In terms of airframe weight, excluding maintenance spares; quarterly.)

[1] Deputy Commanding General, Engineering.
[2] Chief of Procurement Division.

Presented at the Aviation Division Meeting, Los Angeles, Calif., June 3-5, 1946, of The American Society of Mechanical Engineers.

was 5,000,000 lb of airframe weight for the June, 1940, quarter, and increased steadily to 30,000,000 lb for the December, 1941, quarter.

After Pearl Harbor the production curve leaped forward quarter by quarter and reached a peak of 255,000,000 lb in the June, 1944, quarter.

A sharp cut is noticeable after VE-Day, and then reflecting virtual termination of military aircraft procurement after VJ-Day, production by the end of 1945 was down to where it was in June, 1940. Based upon the latest Army and Navy schedules available, production was plotted through June, 1947, at approximately 6,000,000 lb per quarter. Thus ends the historical record and the immediate projection into the foreseeable future.

INDUSTRIAL PLANNING FOR THE FUTURE

After this brief statistical sketch, let us take up the problem of industrial planning for the future. For purposes of this planning the report postulated two peacetime levels of military procurement. One called "Plan A" is what might reasonably be expected to be needed and represents a medium-sized peacetime air force with an annual production rate of 5800 military planes. The other, "Plan B," represents a smaller air force and is considered the absolute peacetime minimum with an annual production rate of 3000 military planes. Estimated figures on a dollar basis, including both military and commercial production, were projected at an annual total of $1,600,000,000 under Plan A, and $900,000,000 under Plan B.

Now, let us focus our attention on Fig. 2 which presents projected mobilization requirements. "19XX" is any peacetime year, for which military production has been projected at the two levels of peacetime procurement; a solid curve for Plan A and a dotted curve for Plan B. The chart projects an increased rate of production far outstripping the comparable period of World War II, reflecting implementation of the air-industrial-planning program.

Fig. 3, entitled Meeting Mobilization Requirements, has been extracted from the report which projects on a comparative chart Plan A for the left half and Plan B for the right half. To carry this accidental football phraseology into football analogy, we might say that the Air Forces would be the "quarterback," while the aircraft industry would be the "fullback" to score the "touchdown" over the production "goal line." Let us concentrate on the requirements of Plan B, under which we would have had a lower peacetime production, and thus would have to make a "longer yardage," inasmuch as we would have started further back from the goal line.

The vertical scale is millions of pounds of airframe weight, while the time scale is years divided into quarters. The lower line represents the transposition of World War II experience 1 year before and 1 year after its "go ahead." The point must be stressed that the mobilization data used in the report are based upon the strategic assumption of a future war comparable to World War II, which was global in nature, necessitating an immediate gigantic shipbuilding program, both naval and cargo, and requiring the raising and equipping of vast land armies. Thus these projected requirements and the estimated meeting of these requirements, based upon the strategic assumption of such a total war, would be altered by a change in the strategic concept. Industrial planning must be kept in tune with military plans and with research and development, which will continuously delve into new fields of air weapons.

This chart projects for the 2-year period three possible production curves. The broken line represents the production expansion which could be expected from the peacetime industry without any planning; it represents a greater output than that achieved in World War II, because we have learned something from this production experience, and because our research and development activity should be many times greater than in the prewar period. The light curve immediately above the broken line represents the output from the peacetime industry, assum-

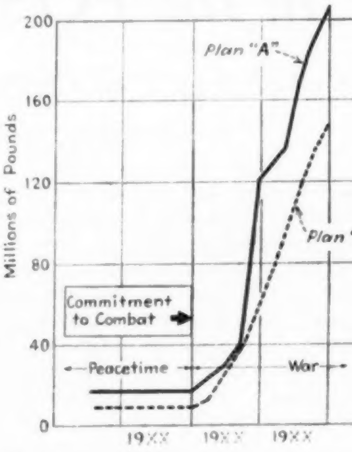


FIG. 2 PROJECTED MOBILIZATION REQUIREMENTS

(In terms of airframe weight, excluding maintenance spares; quarterly.)

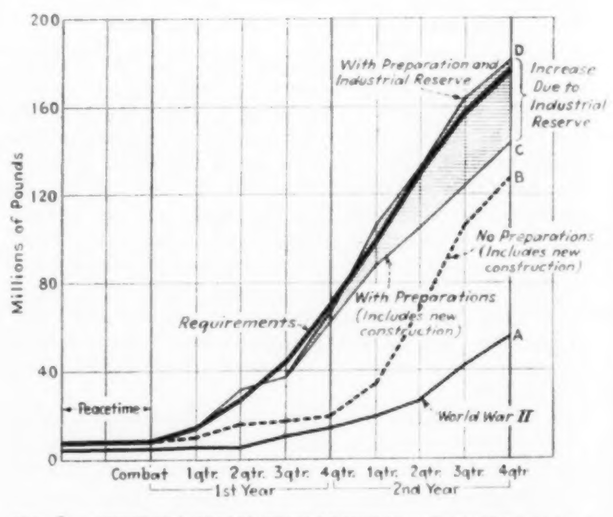


FIG. 3 MEETING MOBILIZATION REQUIREMENTS UNDER PLAN B

(In terms of airframe weight, including maintenance spares; quarterly.)

ing the undertaking of basic preparedness measures. It will be noted that this curve meets the requirements during the first year, but that it falls far short in the second year; this is because the peacetime industry, having been expanded to capacity within a year, now lacks the necessary floor space and equipment to meet the increasing production requirements of the second year. The top light curve assumes preparation and an industrial reserve, and the shaded area reflects the substantial increase in production rate due to an industrial reserve. This last is the only curve that meets requirements at the end of the second year. The heavy line represents projected production requirements, the figure on the chart being around 175,000,000 lb per quarter at the end of the 2-year period. Thus with this production requirement as the goal line, it is seen that we have scored a touchdown just as the whistle blew.

Having examined these charts, showing actual and projected military-aircraft production, let us now analyze in some

detail certain basic recommendations which we may summarize as "four keys to air industrial planning."

RESEARCH AND DEVELOPMENT PROGRAM

The first key is an adequate research and development program that carries through production in limited quantities to provide production proving and service testing.

It is generally recognized that an adequate research program is a basic element of any plan for the maintenance of air superiority. The research staffs of the Air Forces and of industry must keep in the forefront of scientific development, and thus have continuously available designs for the most advanced types of aircraft required to maintain this country's leadership in aeronautics. Then these planes and components must be engineered to meet technical requirements. However, we must do more than make merely experimental versions of the latest and most effective weapons for air power. Production engineering must be recognized as an integral part of design engineering, in other words, airplane manufacturers should so design the plane initially that it could be adapted for mass production and thus eliminate the necessity of subsequent redesigning.

There should be production, at least in limited quantities, for two fundamental reasons. Such production orders will enable the manufacturer to production-test the plane. Then, the existence of a certain minimum number of the plane model will allow operational testing by Air Force squadrons. In other words, blueprints cannot fly and experimental planes cannot fight.

AIRCRAFT-INDUSTRY ORGANIZATION MUST BE MAINTAINED

The second key to air industrial planning is the maintenance of a healthy nucleus of an aircraft industry capable of rapid expansion and supported by a program of continuing military production.

An air-force commander is vitally concerned each and every day with the number of combat planes he can put into the air. Thus a basic gage of air power is the number of planes on hand. Fortunately or unfortunately, it is practically impossible to stockpile airplanes, as a fairly high physical depreciation rate is combined with an exceedingly high obsolescence factor. The report suggests an annual replacement of approximately 25 per cent of our total aircraft inventory. Thus the Air Forces must look to the aircraft-manufacturing industry of today for the planes needed for the emergency of tomorrow.

The military aircraft production record shows 1800 planes produced in 1938, 48,000 planes in 1942, and 96,000 planes in 1944. We owe a debt of gratitude to the number of large concerns which went into the production of airframes, engines, propellers, and major items of aeronautical equipment, and equal gratitude is owed to the thousands of smaller concerns which made available their facilities and skill as subcontractors. It is interesting to note, however, that the specialized aircraft-manufacturing industry, representing those companies which have concentrated consistently on the design and manufacture of aircraft, accounted for 9 out of every 10 airframes produced during the war. Thus the bulk of airplane requirements of the future must come from our peacetime aircraft-manufacturing industry.

The report recommends a certain minimum annual production of military aircraft. The figures set are 3000 military airplanes a year, or its equivalent of 30,000,000 lb of airframe weight. It may be noted that this recommended annual total equals less than 2 weeks' production at peak war rates. At the moment, military aircraft procurement is running even below this minimum level, and as the report points out, this reduced level of procurement is eroding the base for any future expansion. Current production contracts are necessary to keep the strong base created during the war, and to provide replacements of superior design and performance to meet training and operational requirements of the peacetime air units of our Armed Forces. This minimum level of current procurement of military planes will insure that there will be a healthy manufacturing aircraft industry in our country, that major plants will be kept in operation, that specialized labor will increase its manufacturing skill, and that the all-important factor of management "know how" will be preserved.

RESERVE OF PRODUCTION FACILITIES AND RESOURCES

The third key to air industrial planning is the assurance of an industrial reserve of production facilities and resources.

During the past war, floor area increased approximately twentyfold, but of course since VJ-Day there has been a substantial contraction of aircraft-manufacturing capacity. The Government invested in aircraft-manufacturing plants nearly $4,000,000,000, a sum equal to about 3 times the total net depreciated plant value of the automobile industry. A number of these great plants now lie idle and their disposition poses a great problem.

In addition to plants, there is the collateral problem of machine tools. We all realize the magnitude of the problem faced during the war by our great machine-tool industry in producing hundreds of thousands of machine tools. Many of these tools may be excess to the needs of the peacetime economy.

Another physical factor to be considered in production acceleration is that of basic resources, and plans are in process for the Armed Services to stockpile certain strategic and scarce materials.

The Armed Services are now giving very careful consideration to the problem of retaining some of these facilities and stockpiling certain basic resources as an industrial reserve against possible future military needs.

JOINT PREPAREDNESS PLANS OF AIR FORCES AND INDUSTRY

The fourth key to air industrial planning is a program of specific industrial-preparedness plans undertaken jointly between the Air Forces and industry to maintain our newest air weapons in a state of readiness for volume production.

Our objective is to reduce the amount of time required by a company to achieve volume production after the Air Force has placed a production contract or has given the go ahead. World War II production experience indicated that from 3 to 4 years elapsed between go ahead and volume output. This key of industrial preparedness plans should and must substantially reduce this time lag.

Let us take a brief look at the problems facing a manufacturer in getting into large-scale production on an aircraft. To begin with, the airplane must be broken down for volume production, so that a maximum amount of man-hours may be expended in a given area during the shortest period of elapsed time. Thereafter, many manufacturing problems would be concurrent. A complete parts list must be prepared. Tools must be numbered to show their relation to part or assembly in manufacturing operations. Detailed production-engineering drawings must be prepared. Many parts of the airplane must be lofted. Tools must be designed. A bill of material must be prepared, and material requirements calculated. The manpower problems, of course, are legion.

The chart, Fig. 2, on future mobilization requirements showed that we are seeking an over-all industrial expansion within $1^1/_2$ to 2 years. This means that, initially, we must be able to reach volume production on certain airplanes within 12 months, which in turn requires effective industrial preparedness planning. The committee has proposed that certain of

these difficult and time-consuming steps be undertaken in peacetime on a few of the latest and more critical of our air weapons. Thus by solving production problems in advance, and preparing for the necessary steps through which an individual manufacturer must go, there should be a time-saving of 6 to 12 months on such air weapons. This key is very important, as in any mobilization plan, time is of the essence.

CO-ORDINATION WITH OTHER INDUSTRIES

It should be pointed out again that the problems of the aircraft industry represent a major segment, but not all of the over-all industrial preparedness problem facing the nation. Plans for aircraft production must be integrated with plans for shipbuilding, ordnance, communications equipment, and other munitions, together with supporting operational items. Underlying all these plans there must be comprehensive preparations to insure the availability of basic materials, machine tools, plants, manpower, together with procedures for necessary allocation of these resources.

As stated previously the specialized aircraft-manufacturing industry during the entire war period accounted for all but 10 per cent of the airframes produced. However, it is interesting to note that by 1944 outside industries represented by Ford, General Motors, and Goodyear Rubber, were contributing nearly 15 per cent of the total volume of airframes produced. Moreover, in 1944 Ford Willow Run, having tripled its output over the preceding year, manufactured a greater poundage of airframes than any other single plant in the country. This experience of Willow Run is classic; it shows the tremendous volume that a so-called mass-production industry can attain, provided it is given the required time, which in this case was approximately 3 years.

AIRPLANE-ENGINE PRODUCTION

During the past war eight principal models of engines were used to power combat and large transport aircraft. Most of the production prior to Pearl Harbor was concentrated on four

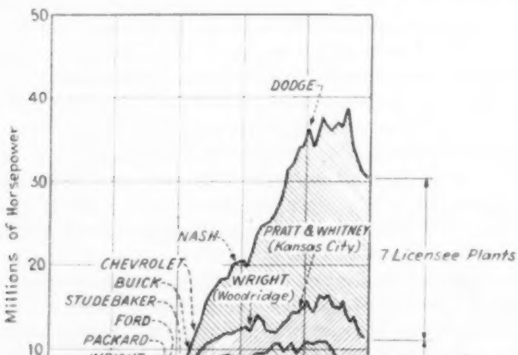


FIG. 4 HORSEPOWER OF ENGINES DELIVERED
(Thirteen plants producing principal models, including spares.)

of these models, all of which were in production in mid-1940, and two of which (the Wright R-1820 and the Pratt & Whitney R-1830) had been thoroughly service-tested by air lines and the military. The four models introduced later in the mobilization period were the Pratt & Whitney R-2000 and R-2800, the Wright R-3350 for the B-29 Super-Fortress, and the Rolls-Royce V-1650 liquid-cooled engine for high-altitude fighters. It is of interest that of the wartime models, the two with the highest horsepower ratings were produced in appreciable quantities only after Pearl Harbor.

Fig. 4, taken from a Harvard Business School Report, shows the horsepower of engines delivered during the period 1940–1944. Pratt & Whitney and Wright Aeronautical had been producing aircraft engines for many years, while Allison, early in 1940, completed its production engineering on its V-1710 liquid-cooled engine. In the middle of 1941 the first branch plant was established, Wright at Cincinnati, and in 1943 a Wright branch was established at Woodridge, and a Pratt & Whitney branch at Kansas City. As production requirements increased it was necessary to bring in outside industries, and the automobile industry wrote a glorious production record; the 7 principal licensee plants being Packard and Ford, which entered aircraft-engine production in 1941; Studebaker, General Motors Buick and Chevrolet, and Nash in 1942; and Chrysler-Dodge in 1944. From this chart it is evident that in the period 1943–1944 these licensee plants contributed a major portion of aircraft-engine output. On the basis of millions of horsepower produced per month and taking the month of December, 1944, as an example, the three home plants produced approximately 5,000,000 hp, the three branch plants 6,000,000 hp, and seven licensee plants 20,000,000 hp.

To summarize the airplane-engine production record, it is seen that prior to Pearl Harbor the three home plants produced all but a negligible quantity of military aircraft engines. For the 5-year period (1940–1944) the production breakdown was as follows: Home plants 38 per cent, branch plants 14 per cent, and licensees 48 per cent. In the peak year 1944 the automobile industry, as licensee, delivered almost 60 per cent of the total horsepower output of aircraft engines.

PRODUCTION HISTORY OF THE P-47 "THUNDERBOLT"

One of our most versatile and powerful planes during World War II was the *Thunderbolt*, P-47. As one watched squadron after squadron of these planes take off for combat, it was hard to realize what a long fight there had been on the design, engineering, and production line before these splendid planes became available for combat. Thus forgetting for the moment the more glamorous aspects of air tactics, personal flying skill, individual courage, let us look at the birth of one of our war planes.

The now famous P-47 *Thunderbolt* series of airplanes was conceived originally as far back as 1938. A predecessor plane, the XP-41, was designed in June, 1938, and was first flown in March, 1939, practically coincident with the time Hitler was tearing up the Munich pact. A second design, the YP-43, was contracted for by the AAF in the first month of World War II. A third predecessor plane, the XP-44, was designed in March, 1940.

As the tactics of air warfare developed on a large scale in Europe, our air staff decided upon a single-engine fighter plane with the desired balance of ruggedness, speed, range, armor, and armament. Thus in June, 1940, the go ahead was given for the P-47.

The fateful year 1941 witnessed first-process engineering, initiation of tool design, and the initial production of tools. In May the prototype was flown. After much further experimentation and testing, the AAF accepted one handmade YP-47 semiproduction model, practically on Pearl Harbor Day.

In April, 1942, the month Bataan fell, the first production model P-47B was delivered. It was not until a year later that the first P-47 squadron appeared over Europe. The cumulative production curve reached the 500th plane in December, 1942, the 1000th in March, 1943, the 5000th in February, 1944, 10,000th in October, 1944, and the 15,000th plane in July, 1945. There were major model changes in April, 1943, August, 1944, and

September, 1944. Thus the P-47 ***Thunderbolt*** was finally evolved as a production-proved combat-tested plane.

Fig. 5 summarizes the time span required to get the ***Thunderbolt*** from the drawing board to enemy skies. The P-47 benefited from 2 years of design work on predecessor models; 6

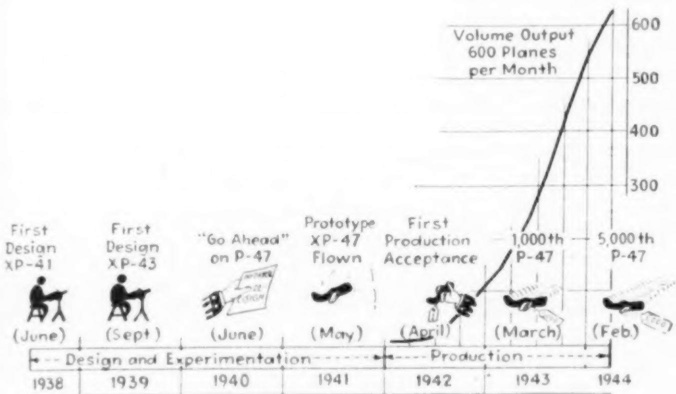


FIG. 5 GENESIS OF THE P-47 FIGHTER PLANE

months elapsed between the go ahead and the initiation of facilities expansion; 11 more months elapsed before the first direct man-hours were expended. An additional 4 months passed before the first production model was delivered. A further 8 months elapsed before the 500th plane was produced. Thus it was nearly 4 years from go ahead to volume output. It should be pointed out that present studies of production acceleration for combat aircraft show that the rate of development of the P-47, instead of being relatively slow, was in reality considerably faster than that of a number of other planes.

From this brief chronology it is seen that this famous fighter plane, one of our key air weapons of World War II, required nearly 6 years from original design to peak production.

It is hard to realize that every plane and engine actually used in combat during the past war, and this is without exception, were designed prior to Pearl Harbor. In other words, in a total of nearly 4 years of war we failed to complete the cycle of design, engineering, producing, and combat-testing a single airplane. In fact, the average period of design to combat test was 5 to 7 years, a very long period as measured by our constantly accelerating standards of research and development and by the shifting nature of international conditions.

CONCLUSIONS

In summary, the Air Forces are concerned with always having an aircraft industry which will be able: (1) To provide replacements of superior design and performance for our air squadrons; (2) to carry on its important share in research and development of new types of aircraft required to maintain our country's leadership in aeronautics; and (3) to expand with sufficient rapidity to meet production requirements in case of an emergency.

The realization of the significance of these "keys" to air industrial planning can be translated in simple terms of so many thousands of additional airplanes which would be available during the first phase of any possible emergency.

The concluding thought of the authors turns to the concept of air power. What is air power? To us its essence seems to be a combination of a powerful military air force in being, strategically located air bases, an intensive program of aeronautical research and development, a strong and healthy nucleus of aircraft-manufacturing industries, and an over all air-industrial-preparedness program.

Collective Bargaining for Professional Employees

(*Continued from page 970*)

shops, as being inconsistent with the dignity and ethics of the profession. They advocate a democratic procedure for action by the membership rather than by dictatorial leaders, and a furtherance of the aims and principles of the professional body. Such principles have not always been apparent in recent actions of the recognized national labor unions.

2 In the professional group there must be strength; strength of leadership, in finances, and in "bargaining power." The group must be strong enough to support its position in discussions with an employer and in disputes with labor unions which may seek to include the professional employees.

3 There must be a definable employee unit which can be shown to be appropriate for the purposes of collective bargaining. This is a difficult problem, as has already been pointed out. Educational qualification is one factor in defining the unit but is by no means determinative. Licensure is another factor but neither has it been determinative in past decisions of N.L.R.B., although Mr. Davis, in the speech previously mentioned, pointed out that licensure might be used as a determining factor.

NATIONAL ORGANIZATION MAY BE SOLUTION

The future of the independent groups of professional employees now being organized may depend upon their combining to form a national organization. October 5 to 7 delegates from the various independent engineer groups on the West Coast met at San Francisco to launch a national organization of professional employees. Such a movement would seem to be the next logical step. Such an organization would have a unifying effect, plus the advantages of numerical and financial strength, a central office equipped to handle the necessary routine office work, and experienced personnel to handle the labor relations. It could study and recommend standards of employment conditions, further educational efforts to inform the public of the profession's aims and services, study proposed legislation affecting the profession, prepare data, and appear before committees of Congress in behalf of the professional men.

We might prefer to have such problems handled through our established engineering societies, the Founder Societies, and the others, including N.S.P.E. Very few engineers question the need for an over-all engineering society similar to the American Medical Association and the American Bar Association, but the engineers, who have been noted for their ability to organize physical things and have contributed in large measure to the world of today through applied sciences, have so neglected the development of the social sciences as to be caught in the wake of the mechanical giant they created.

In the interim, between today's hydra of engineering groups to a unified engineering profession, it will be necessary for professional-engineering employees to maintain professional status and economic equality through the legal processes available to them. Today, the only remedy available by law is collective bargaining under the National Labor Relations Act.

FORGOTTEN PEOPLE[1]

By IRVING KNICKERBOCKER

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

"DURING the last few decades thoughtful executives have been paying more and more attention to understanding the influence of human relations on the efficiency and well-being of their organizations." This is the introductory sentence in the preface of a book on "Human Factors in Management."[2] It may be safely assumed that:

1 The organizations referred to are organizations of people.

2 People in organizations are constantly involved in human relations.

3 Executives accomplish whatever they accomplish only through their relations with people in their organizations and through the relations of those people with each other.

Nevertheless some of the implications of the prefatory sentence are:

1 Up to a few decades ago even thoughtful executives were not particularly interested in understanding the influence of human relations on their organizations.

2 Organizations may be considered on occasion at least to exist apart from the human relations of the people in the organizations.

3 Thoughtless executives still pay little attention to human relations.

People are too often forgotten. Today we are worried about plans for the world-wide organization of nations and the internal organization of countries and the efficient organization of industry. Mostly it seems to be people who make the trouble. The leaders have ideas. The plans sound good. Yet, from the international scene to the industrial, it seems to be the people who are the stumbling block. Either the people are too often forgotten or perhaps not too well understood. It is odd that we should forget the people or, for that matter, not understand them well.

We humans are not solitary creatures. We are born, and we live our lives in contact with other human beings. Most of what we do, we do to and through other people. Most of what we get, we get from or by means of other people. People in our childhood shape our behavior, our thoughts, our emotions, and it is from people for the rest of our lives that we discover whether we have succeeded or whether we have failed, whether we are good or whether we are bad. Neither the idle parasite nor the self-made man achieves his final role except through the medium of other people. We are born powerless and utterly dependent into a cruel and implacable world. All that stands between us as newborn infants and death within a matter of hours or days at the most are people, our parents. Only in a small degree throughout our lives do we escape the dependency upon people with which we start. Most of us do not live alone. Most of us do not work alone. Each one of us satisfies his wants today in general through the agency of other people. Our food and our clothes, the houses we live in, the pleasures we enjoy, the goals we strive for, are all obtained through others. We organize to worship the gods, and we organize to enjoy our sports. We dig ditches together and we are educated together. We govern our communities through organization, and we organize our people to fight our wars.

We are dependent upon people for getting done what needs to be done. In our homes, in the midst of traffic on the street, in the sales department, on the production line, or in the middle of a tennis game, we are dependent upon our ability to understand, to predict, and to manipulate human behavior. To the extent that we are dependent upon people, we must be able to influence people. To influence them, we must be aware of them as people. Too often, however, we forget them. We forget that the members of our family are people. We forget that the clerk, the waiter, the postman, and the fellow sitting next to us, each is a person. We forget that the boss is a person and the subordinate is a person. We forget people.

Managers form organizations to produce services for consumers. The organization is a means to an end for the owners, the managers, and the consumers. It is also, however, a means to an end for the people in it. It is these forgotten people who are being remembered today.

To an increasing extent over the last few years, the problems of human relations, which occur when people are organized to accomplish some purpose, have been studied. The field has been largely the industrial organization, and the motivation to a great extent the attempt of industrial leaders to make a more effective employment of the organization as a means. The results of the study are significant for all organizations. It has been difficult for anyone interested to get an idea of what has been done in this field and of what may be expected. Material of varying significance touching on problems of different sorts, gathered through diverse techniques, interpreted from many points of view, are scattered through industrial publications, psychological and social publications, and probably to an even greater extent still remain unpublished, only partially conceptualized by the workers in the field.

The book, "Human Factors in Management" is an attempt by the editor, Schuyler D. Hoslett, to collect some of the results of the reflection, researches, and studies of business executives, psychologists, sociologists, and anthropologists. Material representing eighteen different contributors is arranged in three parts. The first part deals with the nature and conditions of leadership and the methods for educating and training leaders in problems of human relations. The second part is devoted to the worker in the organization and his problems. The third part contains four theoretical considerations of the material for students of the field.

A book of this sort is an ink blot from which each reader carries away his own conception of what was there. With such differences of approach and conceptualization any interested reader must inevitably find congenial and profitable material.

Anyone who is immersed in the endlessly frustrating tangle of organization work ought to enjoy the article on "Management Mentalities and Worker Reactions" by McMurry. This contribution might have been entitled "the causes of employee dissatisfaction." McMurry has succeeded in putting his finger on many of the causes which we all recognize but which are not

(*Continued on page 991*)

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "Human Factors in Management", by Schuyler Dean Hoslett, Park College Press, Parkville, Missouri, 1946 preface.

ENGINEERS WORK *for* PEACE

International Technical Congress Adopts Resolution at Paris, World Engineering Conference Formed

ABOUT twelve hundred engineers from thirty countries participated in the International Technical Congress held in Paris, Sept. 16–21, 1946. This Congress, the first of an inclusive character since the World Engineering Congress in Tokyo in 1929, gave opportunity for engineers to declare it their responsibility to devote engineering skill to the advancement of human well-being and to call their colleagues to action in the interest of world peace.

The French Committee, under the chairmanship of Colonel A. Antoine, had planned well. The week of discussions and shop visits, high-lighted by a delightful reception at the palatial Hotel de Ville and brought to a climax by inspiring addresses at the closing session, was thoroughly enjoyed by all the participants. Following the Congress there were extended trips to Normandy and the Loire Valley.

At a luncheon on September 18, Mr. Joxe, director of the Cultural Relations Services of the French Ministry of Foreign Affairs, quoted the words of a French master that "Science without conscience is ruin of the soul." He emphasized the fact that the conscience of our day has not only a moral but also a social sense and heralded the fact that engineers should tend to take increased interest in their duties as citizens and in exerting their influence in the task of improving the lot of human beings.

At the final session on Friday evening, September 20, P. Le Rolland emphasized strongly the important responsibilities of science and technology to mankind. The text of his address will be found on pages 961–962 of this issue.

THE SUMMARY RESOLUTION

The work of the Congress was summarized in a resolution which was approved by the assembly at the plenary session of the Congress held Friday, September 20. This resolution follows:

The International Engineering Congress, held in Paris during the week of September 16, brought into relief as the outcome of its work the following essential points:

1 The contribution which engineers and technicians owe to themselves in forwarding the progress of humanity should be directed along social lines which are too frequently ignored. In order that these social lines may be defined with precision and universally accepted, it is fundamental that increased attention be paid to the application of engineering science for improving the environment and sustenance of human beings, and that among such questions, those measurable should be exhaustively studied, applying proved scientific methods.

2 It is therefore necessary to initiate decisive action against the want under which many human beings—constituting an appreciable proportion of the world's population—struggle, and who are thus deprived not only of the primary means of well-being but also of all possibility of spiritual growth.

The most serious and frequent forms of want are: Undernourishment; bad housing conditions and unplanned congested areas; and incapacity due to absence of physical and moral hygiene and to industrial accidents and disease.

Engineers and technicians consider it particularly urgent to:

(*a*) Increase the pace of modernizing agriculture with the twofold aim of increasing the world's food resources and of raising the standard of rural life.

(*b*) Place maximum mechanical and electrical power at the disposal of the individual in order to increase his output both in agriculture and industry.

(*c*) Improve housing for workers and their families by a joint effort of architects and engineers in applying to the construction of lodgings the general progress of arts, sciences, and technology, and in the rapid execution of town plans made under a coherent doctrine.

(*d*) Humanize working conditions in both agriculture and industry by technical studies and accomplishments in accord with the interested parties and by the development of international conventions for the protection of workers.

3 In order that early results be obtained in this battle against want, it is fundamental that the different practicing engineering specialists follow the progress of scientific research step by step and that closer co-ordination be established between them; also that there be a sufficient number of fully qualified men to put them into practice. Hence, in particular:

(*a*) The need for close liaison between research and development and for measures favorable to technical progress in all countries.

(*b*) The urgency of international co-operation for the spreading of technical knowledge, especially by international study or inspection trips, by translation of engineering literature, and also for putting into practice the corresponding knowledge thus gained.

(*c*) Importance of the preceding items in regard to nuclear energy so that it can be put into peacetime application as quickly as feasible.

(*d*) The essential role (in obtaining effective application of the different techniques) of scientific management, which must have mankind as one of its major concerns and must constitute one of the basic elements of the training of engineers, and standardization, which must be developed widely on an international plane in order to offer to the majority of consumers, at constantly lowering prices, easy access to the fruits of technical progress.

(*e*) The urgent necessity of having a high rate of productivity per man-hour uppermost in the minds of all groups.

4 In studying the tasks of engineers and technicians now and in the future, the Congress notes that: Their societies and institutions, whose organization differs widely from one country to another, are frequently insufficiently co-ordinated in national groups; contacts between different countries, through the channels of national groups or of specialized committees, are too limited to permit united effort; and as a result, the governments and the United Nations cannot call upon their services on a scale corresponding to the importance of their tasks.

The prolongation of such a state of affairs, raising an obstacle to the achievement of the different objectives previously stated and, above all, to the success of the battle against want, the International Technical Congress expresses the hope:

(*a*) That within each country, associations of engineers and

Report prepared by C. E. Davies, secretary, A.S.M.E., who headed the American Delegation at the International Congress.

technicians as well as existing technical societies co-ordinate their activities through appropriate joint committees.

(*b*) That a World Engineering Federation, the creation of which has been discussed at preceding congresses, be formed immediately to permit the collective representation of engineers and technicians before private or official international organizations.

(*c*) That the United Nations may to the greatest extent call upon the engineers and technicians, and particularly upon the proposed federation, by giving its general secretariat a technical staff.

(*d*) That there may be created as soon as possible an Administration of the United Nations for housing and community Planning under the authority of the Economic and Social Council of the UN. This administration, in which town planners, architects, and engineers in another field would be associated, should play a very active part, similar to that played by the Food and Agriculture Organization; and an International Institution of Scientific Management, in connection with the United Nations or its appropriate subdivisions, whose work will be to promote and co-ordinate studies and researches in scientific management.

(*e*) That the creation of one or several international technical schools for advanced students be encouraged, the first of which should be installed in Europe in order to facilitate, in the first place, the international technical development of youths who played an active part in the resistance or who are victims of Nazi oppression.

5 Asserting their faith in the vital contribution which engineering can make toward the general betterment of the fate of mankind, particularly by the application of the first program herein stated, the members of the International Technical Congress declare themselves resolved to pursue the fulfillment of this program, and to uphold with all their power the corresponding action.

As a conclusion to their work, they desire to make clear that the scientific and technical methods used to facilitate world progress are valid and effective in all countries; and the efforts of engineers and technicians to raise the standard of living of all people can give tangible results only if peace is assured on a lasting basis, and if all work and resources of the different peoples can be thus essentially consecrated to the works of peace.

U.S. ENGINEERS CONTRIBUTE PAPERS

The technical program which resulted in the foregoing resolution consisted of 130 papers by authors from fourteen countries. Engineers from the United States contributed the following papers to the program:

A—General Engineering Problems of Reconstruction:

(1) Some Observations on World Industrialization, by Morris L. Cooke
(2) Applied Scientific Research, by Joseph W. Barker
(3) Place of Small Plants in Industrial Development, by A. C. Shire.

B—Nuclear Energy, by Harry A. Winne

C—Present Situation of Engineering in the United States: Interdependence of various branches of engineering; Future trends
Relations with engineering developments in other nations

(1) Scientific Management, by John A. Willard
(2) Standardization, by P. G. Agnew
(3) The Impact of Mechanization on Agriculture, by A. W. Turner
(4) Manufacturing, by L. C. Morrow
(5) Town Planning, by Harold M. Lewis
(6) Building and Housing, by Edmund R. Purves
(7) Civil Engineering and Public Works, by Major General Philip B. Fleming
(8) Highway Traffic, by Frederick C. Horner
(9) Distribution, by Fenton B. Turck
(10) Telephone Communication in the United States, by H. S. Osborne
(11) Air Transportation and World Understanding, by J. Parker Van Zandt.

D—Engineers in the United States:

(1) Organizations of Engineers in the United States of America, by C. E. Davies
(2) Technical Education and Professional Training, by L. E. Grinter
(3) International Co-operation in Technical Translation, by James S. Thompson
(4) Activities of the Society for Experimental Stress Analysis, by R. D. Mindlin.

WORLD ENGINEERING CONFERENCE FORMED

The proceedings of the Congress, including all papers printed in the language of the author and also including the summaries of the discussions, will be sent to those who participated in the Congress. Additional sets will be available for sale in the United States and may be secured from the joint Committee on International Relations, 29 W. 39th St., New York 18, New York.

In parallel with the deliberations of the Congress, meetings of representatives from twenty countries were held to consider the feasibility of a permanent organization for the engineers of the world. This consideration resulted in the conclusion to continue the International Technical Congress organization under the name World Engineering Conference. This interim agency has the following objects:

(1) To wind up business of the 1946 Congress.

(2) To prepare for the establishment of a more permanent form of organization.

(3) To assure, if need be, the holding of future international engineering congresses.

(4) To take over certain tasks subsequently to be undertaken by a more permanent organization such as the establishment of contact with the Economic and Social Council of the United Nations, and with the United Nations Educational, Scientific, and Cultural Organization.

Membership in this new Conference may be held by national committees in each country, who will be represented by two delegates. The Conference is to be administered by an executive board of twelve and a president elected by the council. A provisional board was set up, made up of a representative of each of the following countries: China, Egypt, United States of America, France, Great Britain, India, Poland, Switzerland, and Czechoslovakia (arranged in the order of the French spelling). Three vacant places will be filled later by the Executive Board on confirmation by the majority vote of the Council.

Col. Aristide Antoine was elected president of the executive board until the next meeting of the council.

PRESENT AT THE CONGRESS

Among those present at the Congress from the United States were the following: Morris L. Cooke, C. E. Davies, Hugh L. Dryden, F. B. Farquharson, L. E. Grinter, William J. Hargest, Max Jakob, Everett S. Lee, Edmund R. Purves, M. Salvadori, Fenton B. Turck, and Col. Theo. A. Weyher.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Physicists

AT the conclusion of an address which he delivered before the American Physical Society in Cambridge, Mass., April 27, 1946, and on which an article appearing in the Sept. 13, 1946, issue of *Science* is based, Gordon Ferrie Hill, Dartmouth College, Hanover, N. H., said the following concerning American physicists:

The wonders of radar in all its forms, completely unknown 50 years ago, the discovery of the fission of uranium by Hahn and Strassmann, the production of the atomic bomb by the combined scientific power of the United States and England, by the Canadian contribution of the essential materials, and by the vast industrial power of the United States, have given to American physicists a prestige never before enjoyed. They are actually consulted by Congress regarding some matters. In fact, some of them are constantly shouting their advice from the housetops, but they can never expect to attain the prominence occupied by the rulers of the country, the so-called labor leaders, who, when the situation is right, make war on the rest of the nation, and who, at times of national emergency, hold up the nation and demand its money or its life.

The scientists of this nation are not likely to make war on this or any other nation. We are not combative or competitive. We should unite with the scientists of all other nations to outlaw war. No iron curtain should be allowed to enclose and segregate the scientists of any nation.

Science has come to have a prominent place in the life of our nation, but the methods of science have not greatly changed. True, there is emphasis on teamwork in contrast with the efforts of an individual. Great laboratories supplied with very powerful and expensive apparatus can dwarf the work of ordinary college laboratories.

But what kind of people are you going to put into the large laboratories? What ideals are you going to place before them? Merely bringing a lot of men together in one building or center is not necessarily going to bring about progress in science. How did it happen that Chadwick discovered the neutron? He knew from Compton's work what a photon would do if it struck an atom. He knew from long-established principles what an atom would do if it struck another atom. He could identify atoms by their ranges from the abundant data established by the long labors of Rutherford, Blackett, and himself. He possessed a great fund of knowledge and experimental skill and he was a tremendous worker. Would he have been helped or hindered by a lot of clock punchers? I think it is of vast importance that we impress every teacher of physics in our colleges and universities with the view that progress in science depends on *his* knowledge of the domain in which he works, *his* scientific curiosity, *his* scientific imagination, *his* experimental skill and analytical ability, and that progress is likely to be accompanied by the scientific analogues of blood, sweat, and tears.

Heat Pumps

CONCURRENT with recent developments in the field of mechanical refrigeration, considerable interest has been aroused concerning the possibilities of the reversed refrigeration cycle for heating purposes. The principle upon which the heat pump operates is not at all new, but until recently it has not been particularly successful in operation.

In The Institution of Mechanical Engineers *Journal and Proceedings* for September, 1946, an article by Oscar Faber deals with the thermodynamics of the heat pump and describes several heating plants which employ the heat pump.

The term "thermodynamic value of heat" is introduced, which is defined as follows: "The proportion of heat units (compared with the total heat units expended) in a given temperature range which can be converted into mechanical energy, using the most efficient engine conceivable, i.e., the Carnot cycle and a perfect gas."

Thus the thermodynamic value of heat expended between any two temperatures is equal to

$$\frac{T_1 - T_2}{T_1}$$

where T_1 and T_2 are the upper and lower temperatures, deg F abs, respectively.

Table 1 lists the values of the thermodynamic values as T_1 is increased from 501 F abs to infinity, T_2 being held constant at 496 F abs.

The figures in Table 1 are shown in the graph in Fig. 1, which may be extended as high as desirable.

With the basic temperature taken arbitrarily at 35 F a definite quantity of heat H, represented to some scale by $AB = CD = EF$, may be considered. For calorimetric purposes all these are identical; however, they are quite different in thermo-

TABLE 1 THERMODYNAMIC VALUES OF HEAT FROM ANY UPPER TEMPERATURE t_1 OR T_1 TO A FIXED LOWER TEMPERATURE $t_2 = 35$ F, OR $T_2 = 496$ F ABS.

t_1 deg F	T_1 abs	$T_1 - T_2$ deg F	$\frac{T_1 - T_2}{T_1}$
40	501	5	0.010
60	521	25	0.048
80	541	45	0.083
100	561	65	0.116
120	581	85	0.146
150	611	115	0.188
180	641	145	0.226
220	681	185	0.272
270	731	235	0.322
320	781	285	0.365
500	961	465	0.484
1000	1461	965	0.660
5000	5461	4965	0.909
10000	10461	9965	0.953
Infinity	Infinity	Infinity	1.0

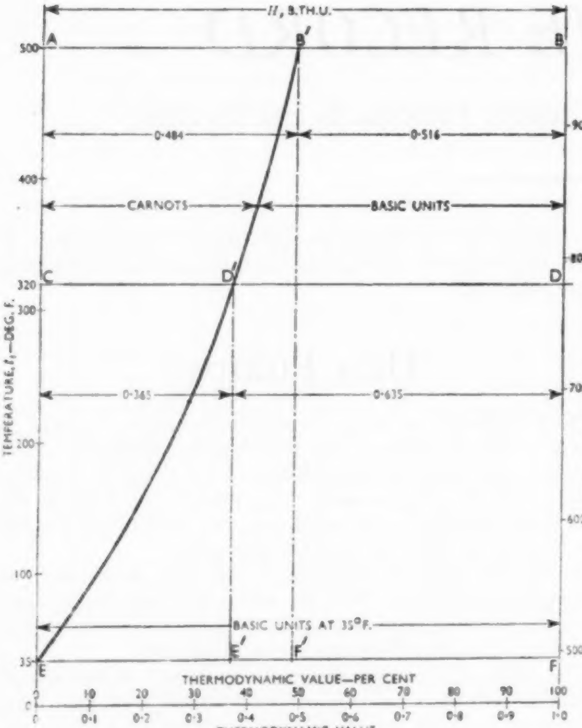


FIG. 1 THERMODYNAMIC VALUE OF HEAT

dynamic value. Of each quantity there is a definite amount which may be ideally converted into mechanical energy, while the remainder must be rejected, having no thermodynamic value whatever. It is proposed to call the former Carnots and the latter basic units.

On this basis, the second law of thermodynamics may be rewritten as follows: "While a Carnot can easily be degraded to a basic unit, a basic unit cannot be upgraded to a Carnot without expending an equivalent amount of mechanical energy."

By virtue of the second law, as just stated, it is easy to convert AB at 500 F to EF at 35 F because this merely requires 0.484 H Carnots to be degraded to 0.484 H basic units. However, it is not possible in the same way to raise H units at 35 F to H units at 500 F without supplying 0.484 H heat units of work or energy from an external source.

As the Carnot cycle is reversible, $EF' = 0.484\ H$ Carnots may be added (by expending 0.484 H heat units of work) to $F'F = 0.516\ H$ basic units at 35 F, to produce H heat units at 500 F. This is the principle of the heat pump.

The work is expended in a compressor in a refrigerator set having a condenser and an evaporator, and (theoretically) $F'F = 0.516\ H$ basic units of heat absorbed by the evaporator at 35 F can be added to 0.484 H units of heat expended as work in the compressor, to produce H units of heat at 500 F in the condenser.

For practical purposes it may be said that $H/0.484\ H = 2.06$ times as much heat has been produced as would have been produced if the mechanical energy had been converted directly into heat, in accordance with the first law of thermodynamics.

This ratio may be termed the "advantage" of the heat pump, and may be defined as the ratio of useful heat delivered at the upper temperature, to the heat equivalent of the energy supplied to the machine. While of course in practice this advantage cannot be fully achieved, owing to the losses by radiation, friction, inefficiency of the compressor, etc., nevertheless it can be closely approached.

As an example of a typical heat-pump installation, Fig. 2, consider that it is desired to produce heat for a swimming bath, at 80 F, from a water source and river at 50 F. By means of calculations similar to those used to prepare Table 1, it is found that at 80 F, with a base temperature of 50 F, there are only 0.055 Carnots to 0.945 basic units. Thus by expending 0.055 H heat units as mechanical energy in the compressor we can take 0.945 H basic units from the river and produce H heat units in the condenser for heating the bath, an advantage of $H/0.055\ H = 18$. That is, only one eighteenth as much electricity need be expended in heating the water to 80 F from 50 F by driving the compressor with a motor as if electricity were used direct in immersion heaters, etc. This of course ignores the motor and compressor losses, radiation, etc. It also ignores the fact that actual machines used as heat pumps are not strictly reversible, since the operation of adiabatic expansion in the Carnot cycle is replaced by expansion through a throttling valve, and this operation is not reversible. Nevertheless, even allowing for these points, an advantage of about 10 can be realized in practice, which represents an important saving.

In industrial application of the heat pump there are two very general cases which should be considered. It may be desired to produce hot water for some industrial process or for a hot-water heating system. Either case might be met by direct heating of the water in coal-fired boilers, or alternatively by using the coal to raise steam for driving a turbine coupled to a heat pump. Fig. 3 is a diagram of a heat-pump installation used to produce hot water for processing. In Fig. 3 (1) is a boiler feeding a steam engine (2) which is coupled to a heat-pump compressor (3); the exhaust from (2) passes through a condenser (7) and is returned to the hot well (8).

The turbine condenser is cooled by river water, at 50 F, which leaves the condenser at a temperature of about 67 F, whence it passes into the condenser (4) of the heat pump and is delivered at a temperature of 100 F. The evaporator (5) accepts water from the river at 50 F and cools it down to some lower temperature such as 35 F and returns it to the river. The compressor (3) raises the refrigerant to a pressure corresponding to a condenser temperature of about 105 F so as to be able to heat the water in the condenser (4) to an outlet temperature of 100 F.

For purposes of comparison, assume that 1000 lb of coal is burned in a boiler of 80 per cent efficiency, assuming a calorific value of the coal of 12,500 Btu per lb. The heat thus obtained would be $1000 \times 12{,}500 \times 0.8 = 10{,}000{,}000$ Btu.

This same 1000 lb of coal will produce 7770 lb of steam, at 665 F, 200 psi, and 285 deg superheat, and allowing for a hot-well temperature of 100 F. Taking the various losses into considera-

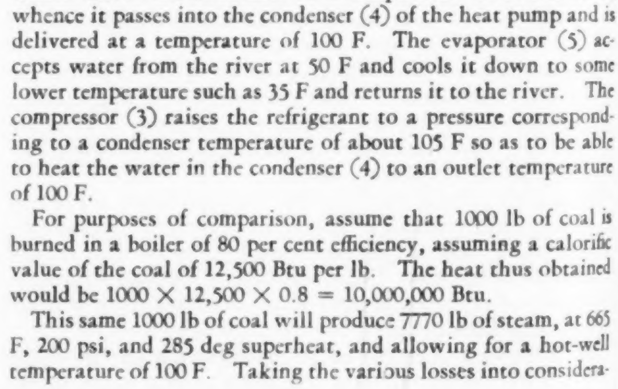


FIG. 2 DIAGRAM OF REFRIGERATION PLANT OR HEAT PUMP

tion, it is found that the heat rejected to the steam condenser (7) is 7,230,000 Btu, and the energy taken from the steam by the engine is equivalent to 980 hp. From test data on a typical compressor it is found that this 980 hp would produce about 13,200,000 Btu in the condenser of the heat pump. Thus the total heat available for heating water is 20,430,000 Btu, which gives the heat pump an advantage of just over 2, compared with the 10,000,000 Btu available by heating through boilers.

Fig. 4 shows a slightly different arrangement in which the application is considered to be a panel heating system requiring 130 F in the supply and 100 F in the return. In this case the return water at 100 F is taken to the heat-pump condenser first and thence to the turbine condenser, where the steam is condensed at a temperature of 150 F. From a series of calculations similar to those in the preceding case, it is found that the advantage of the heat pump is 1.65 as compared with the direct-heating alternative. This reduced advantage is primarily due to the fact that the water is being raised to a higher temperature.

It is clear that whatever may be the advantages of utilizing a heat pump when the source of energy has to be electricity produced by the burning of coal, with its inherent losses, the advantages are even greater when power is available in the form of water in countries like Switzerland, New Zealand, Canada, etc., but fuel is expensive and mostly imported. We should therefore expect to see the heat pump used in such places first, which has been the case.

The town of Zurich in Switzerland contains a district-heating scheme which was linked up with a heat-pump installation, composed of three machines having a total capacity for delivering heat to the condenser at a maximum rate of 8,000,000 Btu per hour. These receive electrical energy produced from water power and make use of the heat in the River Limmat for delivering a larger quantity of heat to the district-heating scheme. From operating records, the advantage of the heat-pump installation is estimated as 2.86. The temperature of the circulating water in the heating system is 70 to 75 C (158 to 167 F).

Two interesting installations of the heat pump are here in America, one in Coshocton, Ohio, and the other in Portsmouth, Ohio. Both are used for cooling in summer and heating in winter, though they operate quite differently.

In the Coshocton plant the cooling load in the summer is approximately equal to the heating load in winter, 405,000 Btu and 410,000 Btu per hr, respectively. Cooling for the refrigerator in summer and heat supplied to the evaporator in winter are provided by water from a well, at 55 F.

In the Portsmouth plant the winter and summer loads are 354,000 Btu and 450,000 Btu per hr, respectively. The chief difference between the two installations is that in the Portsmouth plant the warming of the coils in the evaporator is done by air instead of by well-water. This makes the plant independent of whether well-water is available or not, but it also necessitates very low temperatures in the evaporator in order to obtain heat from the outside air during the winter. An alternative method of spraying the evaporator coils with city water when the temperature of the outside air is lower than 20 F has been tried but has not been entirely satisfactory.

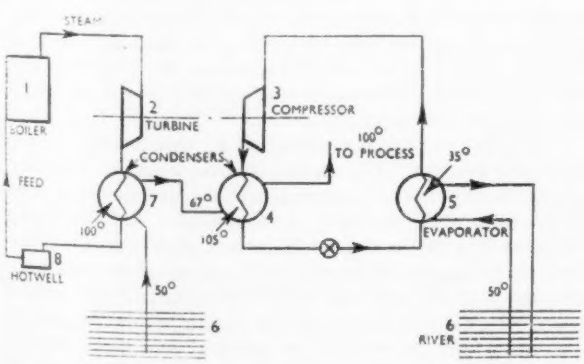


FIG. 3 HEAT-PUMP INSTALLATION FOR HEATING PROCESS WATER

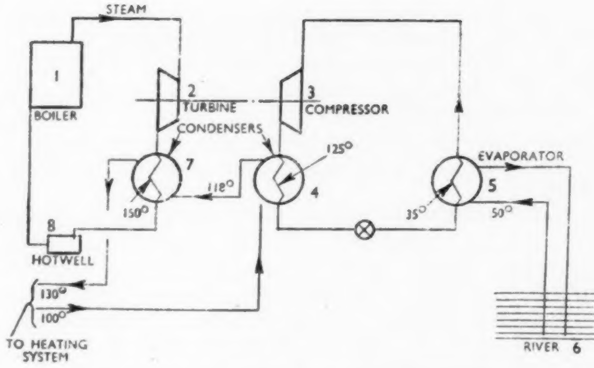


FIG. 4 HEAT-PUMP INSTALLATION IN CONJUNCTION WITH HOT-WATER HEATING SYSTEM

Optical Grinding Machine

A PRECISION grinding machine with an optical system which enables the operator to compare his work with the engineering drawings as the work proceeds has been received from Germany and is available for examination and testing by American manufacturers. The machine is used for making templates, forming tools, cylindrical forms, and other complicated shapes.

The machine, discovered in Germany by Technical Industrial Intelligence Division investigators, was manufactured in 1944 by the Ultra Praezisionswerk at Aschaffenburg. Its optical system was made by the Leitz firm at Wetzlar. The machine has never been used.

An investigator in Germany stated it may be fairly claimed that a new factor has been introduced into machine-tool construction which constitutes a striking innovation in technical practice.

Disk-shaped, the precision grinder is approximately 44 × 58 in. in size and weighs 4500 lb. Located on the front left-hand side is a glass screen plate. A master drawing of the work to be done, etched on cellophane or glass with hydrofluoric acid, is inserted in the plate.

The grinding head and table for holding the work are located at the right of the machine. In operation the work is positioned in front of a lens in the body of the machine and illuminated by an adjustable spotlight. By means of the optical system the silhouette of the work is magnified and projected on the glass plate, so that the master drawing can be superimposed on the image.

Working from a sitting position, the operator controls the grinding operation by two wheels, about the size of automobile steering wheels, located in front of the glass plate.

The operator can gage the progress and accuracy of his grinding work by comparing the lines of the silhouette with those of the master drawing. If the grinding is accurate, the lines will coincide. Since the work is mechanically magnified 16 or 40 times, the operator is not tired by intense observation of his work through a microscope.

It is essential to mount the machine so that it is free from vibration and it should be placed in a dimly lighted room so that the operator may see the silhouette clearly. The master form must be drawn with extreme accuracy, as any error will show up in the finished product.

Though intricate, reports indicate that the machine appears to be speedier and more accurate than hand-grinding methods.

A final estimate of the machine's efficiency will be available after it has been tested under American conditions. Manufacturers interested in examining or testing the machine should communicate with Carl Hoffman, Chief, Materiél Unit, Technical Industrial Intelligence Division, Office of Technical Services, Department of Commerce, Washington 25, D. C. Pictures, preliminary drawings of the machine, and a set of operating instructions translated from the German are available.

Electronic Hardness Testing

THE adaptability and usefulness of electronic methods in helping to solve a large number of problems encountered in the engineering industry are well demonstrated in new instruments developed for the speedy and precise determination of hardness and related properties of ferrous components without the need for destructive mechanical tests. The operating principle of the electronic method described in the September, 1946, issue of ***Aircraft Production*** is based on the electromagnetic peculiarities of ferrous materials, and the fact that mechanical properties are closely related with the so-called magnetic hysteresis.

This hysteresis is induced by surrounding the sample with a cylindrical coil carrying an alternating current. Steel containing carbon or alloying elements, particularly when hardened, shows a marked reluctance to acquire magnetic polarity, but once it is polarized, a considerable reverse current is required to destroy the original magnetic intensity and to polarize the steel in the opposite way. The lag exhibited by steels of different hardness and different carbon or alloying-metal content varies in such a manner that with increased hardness it too increases, and vice versa. A demonstration of this peculiarity may be obtained by comparing a steel of appreciable hardness with pure iron. It will be observed that the curve for the steel is a more open figure, thus indicating its greater reluctance to change polarity. This principle is used as a means of obtaining visual indications of these properties as compared with those of a standard sample. A pair of matched coils, one surrounding a standard sample and the other the piece to be tested, act as the primary stages of a pair of transformers in which the specimens form the cores. Surrounding the primary coils are secondary windings in which the current is induced by the cores when an alternating current is applied, and since the secondary voltages are determined by the properties of the cores, any difference in the specimens will manifest itself in a difference between these voltages.

Such differences, suitably amplified and balanced against each other, are led to the horizontal deflecting plates of an oscilloscope, across the vertical deflecting plates of which is applied a constant 50-cycle alternating-current voltage synchronized with the primary input. This has the effect of rendering visible any discrepancies between the two specimens, so that a greater lag on the part of one or other of them is evident on the oscilloscope screen as a modified or differential hysteresis figure, while coincidence of properties is shown by a nearly straight vertical trace. An instrument of this kind, the Ferroscope, has been developed by Alfred Herbert, Ltd.

A typical example of its use is in the heat-treatment of high-speed steel which can be overhardened so that, although with normal tempering the mechanical hardness may be within the required limits, retained austenite may be present and could be revealed by an examination of the microstructure. Consequently, the steel does not possess its full toughness and freedom from internal stresses. As austenite is softer and much less magnetic than fully tempered martensite, the defect is readily shown by the Ferroscope, whereas it would pass undetected if the usual methods of testing were used.

While primarily developed for the purpose of checking small items such as screwing dies, chasers, and taps, the apparatus is also very suitable, provided the shapes and dimensions of the articles under examination are similar, for examining many other finished or partly finished components, such as screw springs, small shafts, pinions, and gears, in either the hard or untreated condition. The absence of the need for mechanical testing should make the method particularly useful in the aircraft industry for checking some of the very highly stressed parts used, for example, in engine construction, where the indentations produced by mechanical hardness testing would be very undesirable.

Sulphur Determination

AN article in ***Iron and Steel***, July, 1946, reveals that the combustion method for determining the amount of sulphur in iron and steel has recently been improved and is recommended as an accurate and the most rapid method available at the present time. It is particularly valuable for use with alloy steels. The drillings are introduced in a special porcelain combustion boat into a tube furnace maintained at 1250–1350 C and are burned in oxygen at a rate of flow regulated between prescribed limits. It has been proposed to absorb the SO_2 (and SO_3) in $AgNO_3$ solution, to which methyl red is added, and to titrate the resultant HNO_3 with N/200 NaOH. This solution is very dilute and the change of color at the end point, in a solution made opalescent by the presence of silver sulphite, or sulphate, or both, is not recognizable with certainty, particularly in artificial light, though a sharper end point is obtainable by the use of a screened indicator. The use of this absorbent has largely been abandoned in favor of absorption in H_2O_2, but difficulty with the colorimetric end point still remains. The use of a lamp of the daylight type to some extent sharpens the end point, but the titration must be carried out very carefully.

In the apparatus recently marketed by Griffin & Tatlock, Ltd., this difficulty is completely overcome by the application of a potentiometric finish to the titration, using an auxiliary electrode and a galvanometer having an illuminated spot clearly visible in all lights. The end point thus does not rely on the color determination of the observer but on the movement across a scale of a hairline shadow on a bright circular spot. A sharp and unmistakable end point is obtained and the determination can now confidently be carried out by junior staff after some instruction. These conveniences well justify the use of somewhat more complex apparatus.

A complete sulphur determination by this method requires about four minutes. The apparatus is assembled on a tubular, welded, metal stand. It accommodates a galvanometer, a reversible sand glass for timing the combustion, an H_2O_2 bubbler connected by a salt bridge with sintered glass disks to an auxiliary electrode, a microburette with automatic zero and reservoir, and a special stopcock with four arms and two pairs of 90-deg bores for ease in sending the oxygen either through the combustion tube or directly (for stirring) into the absorption vessel. Combustion-boat covers are now available to prevent molten oxides, spattered by the vigorous reaction, from reach-

ing the walls of the combustion tube and so reducing its effective diameter.

The apparatus has been successfully applied to the determination of sulphur in iron, steel, and ferro alloys over the range 0.008 to 0.4 per cent with an accuracy of about ±5 per cent. It has also been used for the estimation of sulphur in sulphide- and sulphate-containing ores such as magnetite, micaceous iron ore, manganese ores, etc., and may be suitable for materials such as coal, coke, and oils.

6000-Bhp Gas Turbine

THE July, 1946, issue of *The British Motor Ship* reports that among the plans which have been prepared for gas-turbine installations for ships by Brown, Boveri and Company, is one for a single-screw 6000-bhp plant, designed for a thermal efficiency of 26.5 per cent, which corresponds to a consumption of bunker C oil or its equivalent of 240 gr (0.53 lb) per bhp hr. The weight, without ship's auxiliaries, is 33 kg per bhp or 73 lb. The engine-room length is about 15 per cent shorter than that of the corresponding Diesel-engine installation. The equipment is designed for an air temperature of 30 C, and a gas temperature of 600 C, which is equivalent to about 1112 F.

There are two power turbines with an ahead and astern section for each and they operate at 4300 rpm, driving the single propeller shaft through reduction gearing at 110 rpm. A fixed propeller is employed. The two power turbines are centrally arranged, with the two turbine-driven compressors in the wings. On the starboard side of the engine room are two Diesel-engined generators and to port a single unit of the same size for the supply of current throughout the ship.

A higher efficiency than that mentioned could of course be guaranteed if larger preheaters be used, but it is considered that in pioneer installations it is desirable to simplify the plant in so far as possible and to develop later toward improved fuel consumption when favorable practical results have been obtained.

The efficiency of a gas turbine of this type is dependent upon the capacity of the preheaters, and they should be designed to combine the maximum heating surface with the lowest flow resistance. The engine-room plans show the arrangement adopted in order to obtain the greatest surface of preheaters without the dimensions being excessive.

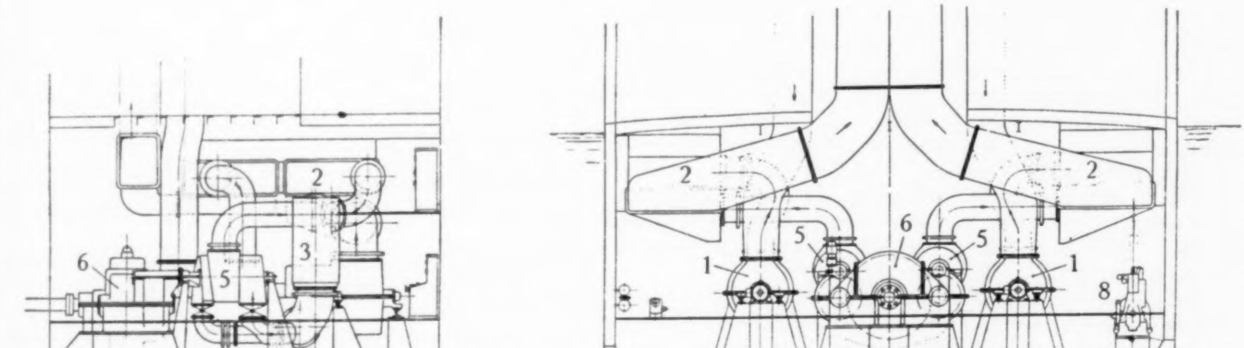


FIG. 5 6000-HP MARINE GAS-TURBINE INSTALLATION

[(1) Compressors. (2) Air preheaters. (3) Combustion chambers. (4) Turbines driving compressors. (5) Power turbines for ahead and astern. (6) Double-reduction gearing. (7) Starting motors. (8) Diesel-engined generators.]

An alternative arrangement lies in the adoption of a variable-pitch propeller, which would give an installation of approximately the same weight and size. It is understood that the cost of the plant is about equivalent to that of a corresponding direct-coupled Diesel-engine installation, and delivery could be given of this set within about 14 months under the usual guarantee. This applies both to the fixed-blade and the variable-pitch propeller installations, but no doubt if electric transmission were employed the cost and weight would be increased.

All-Steel Motor

A NEW all-steel alternating-current motor, more than 35 per cent smaller in size than its predecessor, was announced by Westinghouse Electric Corporation, at a press conference held in the Hotel Astor, New York, N. Y., on Sept. 12, 1946. The reduced size has been accomplished without sacrifice of electrical properties. Starting torques have been increased as much as 134 per cent per lb of motor and maximum torques increased as much as 116 per cent per lb of motor. High efficiencies and power factors are maintained. The appearance is much improved and maintenance requirements materially decreased. Specifically, the bearings will need no attention for at least five years. Shock resistance is increased manyfold. Vibration and noise have been reduced to new low limits. Fewer insulation burnouts will be experienced because of new features in insulating materials and improved winding techniques. "In short," said F. C. Rushing, member A.S.M.E., manager, motor engineering, Westinghouse Electric Corporation, Buffalo, N. Y., "this newest squirrel-cage motor takes its place with four or five other peaks of progress in motor history."

The use of steel instead of the more conventional cast iron makes this motor stronger since the structural-steel sections used are as thick as they would be if made from cast iron.

The finish coating of the new line of motors consists of base coats of baked thermoset varnish with a final coat of lacquer. Tests and experience have demonstrated that steel with this

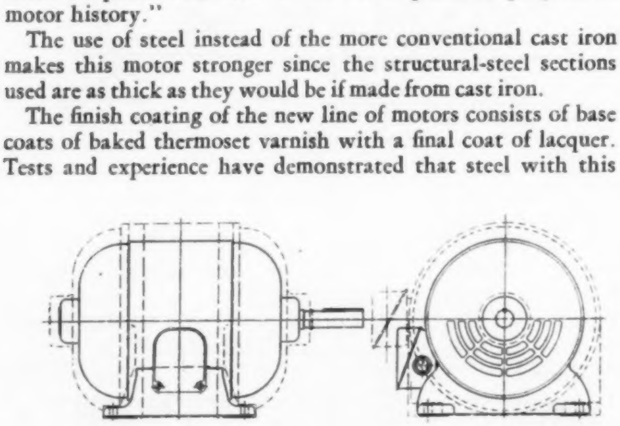


FIG. 6 COMPARATIVE SIZES OF $7^1/_2$-HP MOTORS.

[Outside dotted line shows old model. Open-protected type (*top*) requires only 65 per cent as much space, while a totally enclosed fan-cooled motor (*bottom*) requires but 56 per cent of former volume.]

finish is adequately corrosion-resistant for general application. In some extremely severe applications, such as in chemical plants, stainless steel will be used for shields and hoods.

Improved appearance in surface smoothness is made possible by the use of steel. Much attention has been given to the contour of this motor, for applications such as machine tools, where the motors are in the open.

The use of steel has resulted in smaller size. In motors, minimum clearances must be maintained between windings and grounded parts of the frame. Since dimensions of formed steel parts can be held more accurately than those in iron castings, allowances for large variation in cast iron do not have to be made. This may amount to a saving of one-quarter inch on a 10-inch diameter or length.

Size is also reduced by an improved engineered cooling system. Much more air passes through this motor than through its predecessor, thus permitting the reduction in size of the cooling surfaces while adequately maintaining temperature limits.

Smooth quiet operation has been accomplished by proper choice of slot combinations and of winding distribution; thus disturbing electrical harmonics have been eliminated and reduced.

Precision manufacturing and quality control give concentric air gaps which reduce distortion due to remaining harmonic forces. Bracket bearing bores and frame fits are machined in one setup on a multiple-head machine. Bearing fits are later qualified and are checked with a precision air gage. Frame fits are concentrically machined relative to the punching bores in a double end lathe.

Mechanical harmonic forces produced by unbalance are eliminated by dynamic balancing in a dynetric balancing machine.

Prelubricated ball bearings are used throughout. They require lubrication no sooner than five years after the motor is placed in operation.

To simplify and facilitate the winding process, slot shapes and sizes, coil shapes and sizes, and connections were all redesigned. The slot openings were enlarged. Winding is therefore much easier and there is less handling and bending of the coils with a consequent reduction of damage.

Winding materials of high quality, synthetic-resin-covered wire are employed.

Several types of motors are attained through extensive interchangeability of parts. The manufacture and conversion of different types is therefore simplified, thus improving deliveries.

Noiseless Mechanisms

AN abstract condensed from *V.D.I. Zeitschrift*, Jan. 9, 1943, and appearing in the July, 1946, issue of *Product Engineering* reveals that the demand for noiseless or nearly noiseless electrically driven typewriters and bookkeeping machines places certain requirements on the drive of these precision mechanisms. Shock and frictional loading must be avoided, not only because of the noise they cause, but also because of the resulting interference with proper meshing of gears and chain drives. The high speed ratios and short distances between shaft centers cause accelerations and decelerations that result in shock.

Since the effect of shock increases with the modulus of elasticity, it is desirable to utilize lightweight materials in the construction of such machines.

It is also possible to achieve noise reduction by structural means. For instance, a nearly noiseless worm-gear drive can displace a noisy link-chain drive as shown in Fig. 7 (*a* and *b*

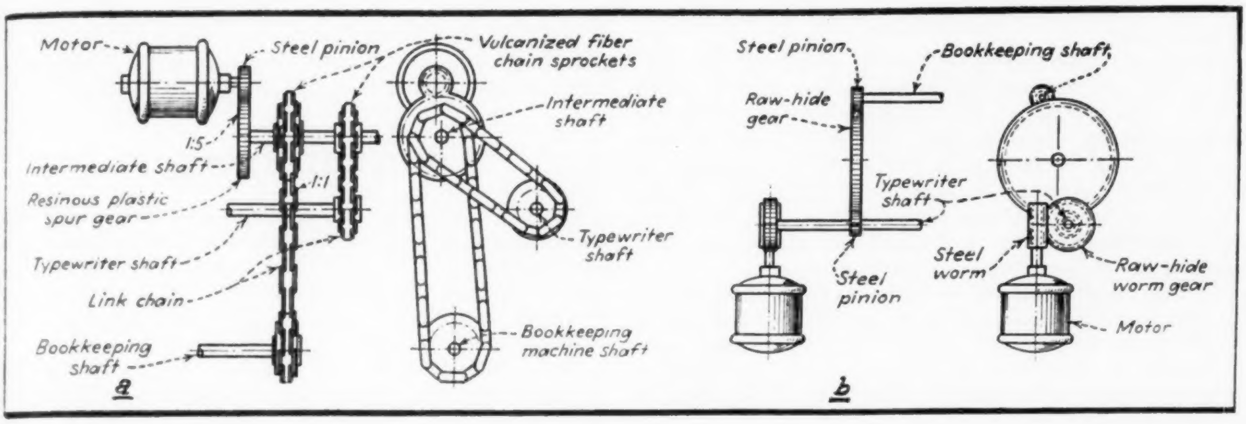


FIG. 7(*a*) TYPEWRITER AND BOOKKEEPING MACHINE WITH NOISY POWER TRANSMISSION. (*b*) REDESIGN FOR QUIET POWER TRANSMISSION

In this drive consisting of a single electric motor equipped with two transmission shaft extensions, one for driving a typewriter and the other for driving a bookkeeping machine, noise was adequately eliminated. The original drive shaft was mounted in a special frame underneath the typewriter. An attempt was made to silence the operation by cutting the intermediate spur gear from a hard woven material impregnated with a resinous plastic and cutting the chain sprockets from vulcanized fiber. The result was only partially successful.

Further analysis led to a basic revision of the drives and layout in which the electric motor was relocated from underneath to the side of the typewriter and equipped with a worm-gear transmission drive as shown in Fig. 7 (*b*). The requisite speed reduction of 15 is obtained by the steel worm through a rawhide worm-gear wheel, which is keyed to the typewriter drive shaft. The bookkeeping-machine drive shaft is driven by a rawhide intermediate gear wheel from the typewriter drive shaft. This redesign silenced the machines.

Plastics Cutting

TRANSPARENT acrylic plastics may be sawed with the same power equipment used for metal and wood, but special circular, band, and jig saws insure maximum production and finish. Complete transparency, so essential to the function of this material, can be maintained only by close control of sawing technique.

An article by W. W. Farr, chief technical service representative, Rohm & Haas Company, in the *American Machinist*, Sept. 12, 1946, describes how special blades and templates, and careful selection of speeds, feeds, and coolants make possible maximum production and proper finish of plastic parts.

More power is required to cut acrylic plastics than wood and a 10- or 12-in. saw blade will require at least a 3-hp motor. With generous powering several sheets of plastic can be cut at the same time, provided suitable jigs are used. When high production is desired multiple sawing will more than offset the increased power costs.

Selection of the proper saw depends upon the type of work to be done. Circular saws should be employed for large pieces. Large-diameter blades cut longer between sharpenings and the teeth have more chance to cool during each revolution. Band saws are preferable for cutting thick material as the teeth have greater cooling capacity. A table saw is recommended for cutting large flat sheets if production warrants this additional equipment.

Hollow- or concave-ground saws provide the necessary side clearance and a minimum of chipping and binding on the thinner acrylic pieces. Blades which are sufficiently hollow-ground do not require "set" teeth, give a smoother cut, and require a narrower kerf. A spring set is better for slightly thicker material. To obtain a smooth edge, the teeth should be "side-dressed" on the machine after they have been set.

The heaviest kinds of cutting should be done with a swaged-tooth saw. The tips of the teeth of this saw are widened so that the width of the cut is greater than the body of the blade, giving adequate side clearance. These teeth should be side-dressed to obtain a good edge cut.

In all cases teeth should be of uniform height and the same distance from the center of the blade. Teeth of uneven length will cause excessive chipping and concentrate cutting strain over a few teeth. Hook or "rake" of teeth should be uniform and in line with the center of the blade.

The blade may be made of special alloy steel, semi-high-speed steel, high-speed steel, or may be tipped with cemented carbide, depending upon the investment the fabricator wishes to make. Life of the blade between sharpenings increases in the order listed. Any of these blades should be properly tempered for the specific operating speed.

Work must be held firmly so the saw moves through the plastic in a straight line parallel with the saw blade. A hold-down prevents chattering, as well as uneven cutting and chipping. A slitter placed directly behind the saw blade prevents kerf from closing in on the retreating edge. Such closing results in a burned black cut which not only destroys the surface of the cut but also tends to heat and dull the saw.

Plastic pieces may be masked with paper and scribed directly with a pencil. If close tolerances are required the material should be scribed directly. Layout templates of highly polished plastic, with handles cemented to the opposite surface, may be safely used on acrylics. If metal templates are used the working face should be covered with fine felt.

Saw guides should be adjusted as close to the saw as possible and should control the "weave" of the blade. With a circular saw the blade should be adjusted to a minimum height with relation to the table and thickness of stock.

Vibration should be further controlled by using stiffener washers at the shaft of the circular saw. Smooth edges at the exit end of the piece are obtained by lowering blade speed as the blade leaves the cut.

Selection of the saw blade is the most critical factor in the efficiency of the cutting operation and in the quality of surface.

If a good smooth cut is obtained, subsequent polishing will be minimized.

Saws should be run at peripheral speeds of 8000 to 12,000 fpm, depending upon the coarseness of the teeth. Acrylics should be fed at a fairly slow rate to prevent overheating. Moderate smoking and smearing of the pieces will indicate that the feed is too fast. As the teeth begin to dull the speed should be progressively decreased. As thickness of the piece increases, coarser teeth and an increased feed should be used. Final determination of the best feed will depend upon observation of the operation and the condition of the piece being cut.

Transparent acrylics, soft and pliable by nature, may be easily worked, but once an efficient technique is developed, it should be followed closely. Any change in operating technique will be accompanied by heat variations, which readily leave their mark on the material and may affect their location in final assembly.

Saws may be run dry, although some acrylic fabricators report that coolants improve the life of the saw and the quality of cut. The saw should be carefully guarded as saws running at recommended speed will throw cooling liquids violently. A large volume of liquid will cool better than a high-velocity jet.

Water-oil coolants should not be used to cut masked sheets unless the masking is to be removed after sawing. The paper absorbs the liquid and reduces the protective qualities. A bar of tallow held against the saw during cutting serves as an efficient lubricant when high production is not required.

Broaching

BROACHING was employed during the war to a greater extent than ever before to speed up production. The advantages of this process are now being applied in manufacturing many peacetime products formerly made by other methods.

An article by O. W. Bonnafe, research engineer, The Lapointe Machine Tool Company, Hudson, Mass., in *Machinery*, September, 1946, reveals that good finish with close tolerances, high production, long tool life, low cost per piece, the use of unskilled labor, savings in floor space, and reduced material waste are the primary reasons why the broaching process is being adapted to the manufacture of so many varied products.

Standard broaching machines can be used for a variety of different operations by the ingenious design of broach bars and fixtures. The adjustable length of stroke and cutting speed of most modern broaching machines permit the machining of many different sizes and shapes of workpieces. Tiny carburetor jets, as well as massive machine-tool frames, are being produced by the broaching process. Broaches have been made as small as 0.04687 in. in diameter, and as large as 14 in. in diameter × 100 in. long, weighing more than a ton.

Since the tooth of a broach is in contact with the work only during the time required for it to traverse the length of the surface being machined, broach teeth maintain their size and sharpness for long periods.

Broaches are commonly of the pull type. Push broaches can be used for any operation performed by pull broaches, but are usually restricted to jobs requiring the removal of only a small amount of stock as they must be shorter and stiffer than pull broaches in order to withstand the ram pressure.

Broaches are made in solid, built-up, and inserted-tooth types. Solid broaches are machined, hardened, and ground from bar stock. The built-up type is used for the larger sizes of broaches or where frequent replacement is necessary. Tools of this type consist of ring broaches or broach shells mounted on an arbor. High-speed steel is used almost exclusively in the manufacture of broaches. The use of carbides was found to be of little advantage because of the low cutting speeds used in broaching. Heat-treated materials as hard as 450 Brinell have been successfully broached with high-speed steel cutters.

Nuclear Energy

SOME of the possible applications of nuclear energy and what can reasonably be expected from it were discussed in a paper by Harry A. Winne, member A.S.M.E., vice-president, General Electric Company, Schenectady, N. Y., which was presented before the International Technical Congress, Paris, France, in September, 1946.

The probable peaceable uses of nuclear energy which appear on the horizon today may be divided into two broad classes: (*a*) The production of power for industrial and domestic use; and (*b*) the production of radioactive isotopes for biological, chemical, metallurgical and other uses. The use of atomic explosives to produce desirable (?) results, such as blasting the ice caps in the polar regions, has also been suggested but hardly seems likely.

One of the considerations is a possible form of nuclear power plant and some of the engineering problems which must be solved to make it a reality. In a nuclear reactor or "pile," the energy resulting from fission appears as heat, at almost any temperature at which we wish to, or rather can, use it. No feasible way is seen today of extracting this energy directly as electric power, and so the ways and means of extracting the heat and converting it into electrical power must be accomplished through more or less conventional apparatus.

It seems reasonable now that the first atomic power plants will consist of the following major elements: (1) A nuclear reactor or power pile in which chain reacting fission takes place, generating heat, which is absorbed by (2) a heat-transfer medium, either a liquid or a gas, which will absorb the heat generated in the pile and deliver it to (3) a heat exchanger, in which the heat will be delivered to a liquid, converting it into a vapor or to a gas, which in turn will be delivered to (4) a steam or gas-turbine - electric generator unit, with necessary accessories.

As to probable or possible applications of atomic power, one of the most likely seems to be propulsion of naval vessels. It is conceivable that an atomic-powered ship might have a range of hundreds of thousands of miles without refueling. This, of course, would be of great importance to a navy and might readily justify a high first cost and high fuel cost. The heavy shielding required for the nuclear unit would not be a serious handicap on a large ship. Atomic power sounds particularly attractive for submarine use, provided space can be made available for the shielding.

As development proceeds, following application on shipboard may come land power plants in locations where power is needed but ordinary fuel cost is very high.

Application of an atomic power plant on a locomotive seems remote and perhaps impossible because of the space and weight requirements of the shields. The same factor makes the application to inhabited aircraft an extremely difficult problem. And it must be obvious that direct use of atomic energy in an automobile, or in one's home, is for the foreseeable future entirely out of the question.

Another application of nuclear energy which may well bring as great or greater benefits to humanity than the production of industrial power is the manufacture of radioactive isotopes through the exposure of selected materials to the high-intensity neutron flux in a nuclear reactor. Radioactive isotopes of carbon, iodine, and other materials will unquestionably be used

in the diagnosis and treatment of human ailments. Their use opens up a whole new method of study of botany and biology. Through the use of radioactive tracers we shall find out much that we wish to know about chemical and metallurgical processes.

Because of the immense military importance of the atomic bomb, and consequently of uranium metal and ores, political factors are apt to have a determining effect on the rate of development of peacetime applications.

The world's only hope of preventing an atomic armament race, and the resultant atomic warfare, lies in some effective scheme of international control of the development of atomic energy, such as that proposed by the United States' delegate to the United Nations Atomic Energy Commission. And certainly, unless we prevent atomic warfare, all the most wonderful beneficent results we can envision from the use of atomic energy are as nothing to us.

Photogrid Strain Analysis

THE first published report describing the use of photogridding for strain analysis, the technique of applying the grid to a metal surface, and subsequent strain measurement are discussed in an article by W. F. Brown, Jr., and M. H. Jones, department of metallurgical engineering, Case School of Applied Science, Cleveland, Ohio, in *The Iron Age*, Sept. 12, 1946.

An evaluation of the metal characteristics for a given forming operation often requires that both the magnitude and distribution of the strains over the part contour be studied. Such information is also necessary for many of the tests performed in the metallurgical laboratory.

Thus the distribution of strain over a whole contour in two perpendicular directions may be required or perhaps the strain over various gage lengths along a given axis. In addition, it is often necessary to determine the change in strain as a function of some other forming variable such as the applied load or the progress of stroke in a press operation.

All of these problems which relate to surface strains require that some reference marks or lines of known spacing be applied to the metal surface before forming in such a manner that the strain over a given length can be determined by measuring the distance between a pair of these lines after or during the progress of forming. Any such series of lines must possess the following important properties: (1) Sufficient accuracy and uniformity of spacing to yield the desired accuracy of strain value, (2) be well-delineated, of uniform width, and remain defined after considerable straining has taken place, (3) must not be destroyed by the forming operation nor by any medium in contact with the metal during forming, (4) must not affect the metal properties to be studied, (5) in addition, particularly if any parts or specimens are to be studied, the reference marks must be easily and rapidly applied to large areas of the metal and to various contours.

The large amount of experimental work on the forming of aluminum-alloy sheet carried on during the war at the metallurgical laboratory of the Case School of Applied Science led to the development of a photographic process by which an orthogonal grid can be applied to the metal surface in somewhat the same manner as in the process of photoengraving. Refinements of this technique led to grids possessing all of the previously mentioned qualities and to a process which yielded gridded specimens in large quantities and requiring only unskilled labor.

The method employed involves the application of a light-sensitive emulsion to the metal surface, the contact printing of a negative of the required grid, and final development of the grid in an ordinary black dye solution. Also, several special techniques of strain measurement were developed in connection with studies of the tensile test and certain bending processes.

The process was developed in the metallurgical laboratory of the Case School of Applied Science in connection with research work carried out under contract with the War Metallurgy Committee.

6000-Hp Diesel-Electric Locomotive

PRODUCTION of a new line of Diesel-electric locomotives designed to meet every motive-power requirement of modern railroads was announced by the American Locomotive Company, Schenectady, N. Y., on September 22, 1946, with the showing to the railroad industry of a streamlined 6000-hp Alco-G-E Diesel-electric locomotive in the private siding of the Hotel Waldorf-Astoria, New York, N. Y.

The locomotive, 75,000th built by the company, is to be delivered to the Santa Fe Railway System for service on its first passenger runs between Chicago and the west coast.

It consists of three 2000-hp units, normally an "A" unit with an operator's cab, a "B" unit without a cab, although it may have hostler controls, and another A unit. With this composition no turn-around is required, as the locomotive can be operated from either end. In addition, the locomotive can be operated at 4000 hp with two A units, or an A and a B, which may be all the power required on some railroad runs, or a single 2000-hp A unit may be used for either light passenger hauls or fast freight transfer work.

The three-unit 6000-hp locomotive weighs 450 tons and has an over-all length of 194 ft, 10 in.

Specifications for the A unit only (2000 hp) include a length of 65 ft, 8 in.; height 14 ft, 11 in.; wheel base 49 ft, 8 in.; weight 304,500 lb; weight on driving axle 50,750 lb; starting tractive effort 61,000 lb; two six-wheeled trucks; wheels of 40 in. diameter; a single V-type, 16-cylinder, 4-cycle Diesel engine, 9-in. bore and $10^1/_2$-in. stroke; fuel-oil capacity 1200 gal; lubricating-oil capacity 250 gal; and speed up to 120 mph.

The underframe as well as the entire cab structure above the trucks is of all-welded construction. Accessibility is provided throughout the interior to all parts requiring maintenance. There is a clear aisle space around the Diesel engine and auxiliaries, with ample clearance for removal of parts.

Through the use of a constant-pressure G-E turbosupercharger extra horsepower was built into this engine so that it delivers a full 2000-hp input to the generator for traction purposes.

Constant-pressure turbosupercharging is a method of utilizing the hot exhaust gases efficiently to drive a gas turbine. This in turn operates a compressor which forces air into the cylinders at high pressure. Getting more air into the cylinders not only thoroughly cleanses the cylinders of exhaust gases, but permits more fuel to be burned with resulting higher output of power from the engine.

The generators, traction motors, controls, and other electrical equipment on the Alco-G-E Diesels are manufactured by the General Electric Company, Schenectady, N. Y. The chassis, trucks, and other mechanical equipment, as well as the Diesel engines, are made by Alco.

Facilities at the Alco plant, which cover an area of 112 acres, will be devoted to mass production of Diesel-electric locomotives, using the principle of station assembly-line methods of construction.

FIG. 8 NEW 6000-HP DIESEL-ELECTRIC PASSENGER LOCOMOTIVE

It is said that this marks the full-scale introduction to the locomotive industry of production of standardized units by mass-production methods.

The new Diesel-electric locomotives have been designed to permit assembly by units, each unit being complete including mechanical, electrical, and other components. The Diesel engines themselves are manufactured on an assembly line, evolving as they move along a production line, with designated station stops for assembly operations.

The Diesel erecting shop has been expanded to 230,000 sq ft. Here locomotives will be assembled in sections and subassemblies with units coming together on the main assembly line.

The shop layout will provide for a straight-line assembly with subassemblies in shop bays. For example, in one shop bay all sheet-metal parts will be constructed, such as nose sections, roof sections, radiator compartments, tanks, and battery boxes. In another operation, underframes and side trusses will be built, and in still other subdivisions, contactor compartments, completed radiator compartments, auxiliary-drive assemblies, and other units will be manufactured.

These in turn will flow onto the main assembly lines in sequence as needed and the completed locomotive will emerge at the end of the combined operations.

Some of the other features of the new Diesel-electric locomotive include: (1) More powerful, lighter-weight Diesel engines which are reported to be 100 per cent more powerful on a displacement basis than the conventional heavy-duty railroad Diesels; (2) Interchangeability of parts (98 per cent of all wearing parts on the passenger and freight models of the new line are interchangeable, which reduces the inventory of spare parts which a railroad operating both models must keep on hand); (3) smoother starts and stops, an essential for modern passenger trains. This is the result of a power-plant regulating system using both hydraulic and electrical controls.

Other features of interest are appearance of the streamlined locomotives and the cab facilities for use of the engineer.

The engineer sits in a comfortable executive-type chair, with easily accessible controls and illuminated control signals. All air entering the cab is filtered and changed several times a minute at proper temperatures. This purified air in turn is used for combustion, compressors, and traction-motor blowers. Excess heat is removed through ducts and blowers.

The engineer has clear vision through wide windshields. A gage board at the engineer's right is illuminated at night with ultraviolet "black" light. A second gage board at the left of the cab includes steam heat gages and controls. The steam is used for heating the train. All controls for the three units are handled from the cab at either end.

N.A.C.A. Wartime Reports

THE National Advisory Committee for Aeronautics has recently released reprints of wartime reports originally issued to provide rapid distribution of advance research results to an authorized group requiring them for the war effort. These reports were previously held under a security status but are now unclassified and have been reproduced without change in order to expedite distribution.

A variety of reports, too numerous to list, have been received by this office. Further information concerning them may be obtained from the National Advisory Committee for Aeronautics, Washington, D. C.

World's Largest Pumps

SIX one-billion-gpd pumps—said to be among the world's largest—with impellers 10 ft in diameter, keep Cincinnati dry during Ohio River floods.

An article in the August, 1946, issue of *Power* describes them.

These pumps are axial-flow, propeller, vertical-shaft type. Each 10-ft runner has four fixed vanes and discharges vertically upward through a 6 vane diffuser, Fig. 10. Pump capacity is probably the highest ever built for their type: They deliver more than their rated capacity, 1500 cfs (1,000,000,000 gpd) when there is less than a 29-ft differential between water level above and below the plant. With a 10-ft pool differential, pump capacity increases to 1850 cfs (1,188,000,000 gpd). An 18-in. shaft, 32 ft long, connects each pump to its General Electric 6500-hp 180-rpm synchronous motor, with a Westinghouse full-voltage automatic starter.

Discharge from each pump divides into two passages of siphon design. On the siphon's top a 9-ft-square radial gate controls each passage. Each gate connects to its own hydraulic-operating cylinder and piston through a piston-rod assembly. The hydraulic cylinders for the two gates on each pump have a common control and oil-and-air-pressure system,

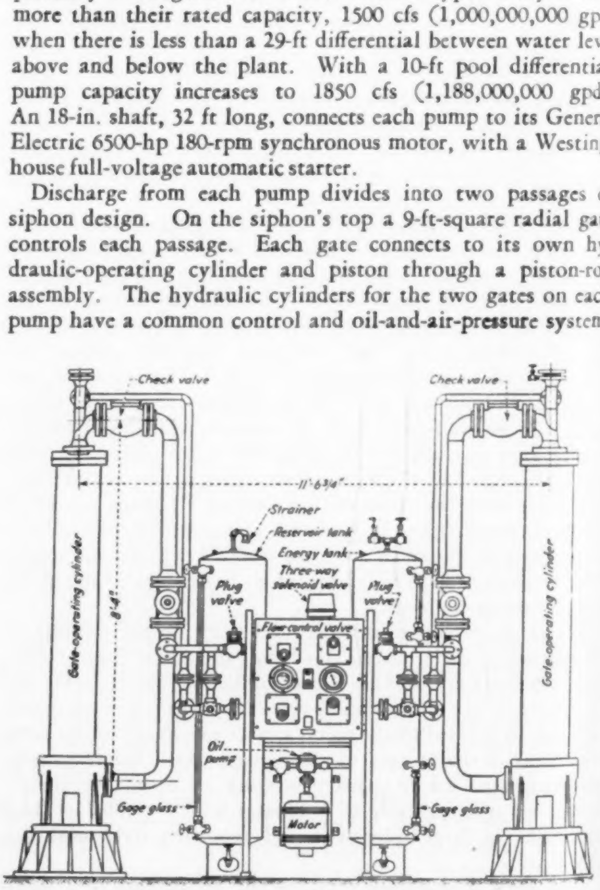


FIG. 9 HYDRAULIC SYSTEM OPERATES ONE PUMP'S TWO RADIAL DISCHARGE GATES

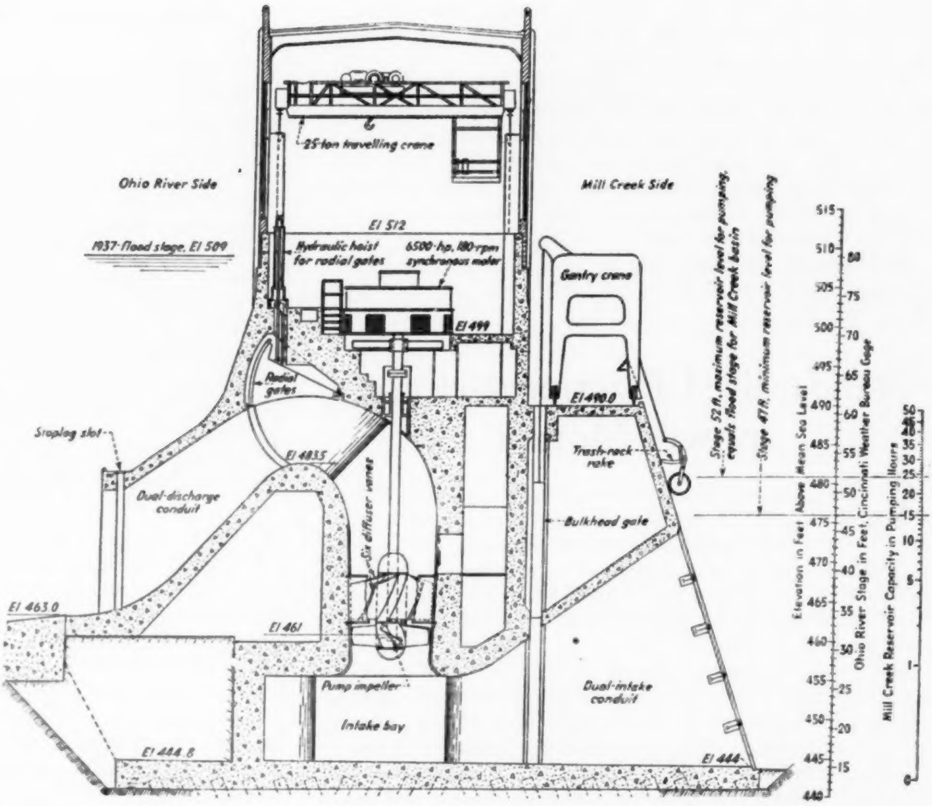


FIG. 10 CROSS SECTION THROUGH PLANT AND PUMP

Fig. 9. Operating cylinders are on left- and right-hand sides of the figure, with the energy and oil-reservoir tanks just back of the control panel.

Having to start the pumps from a closed-gate condition created an interesting problem. If the gates were to remain closed until the pumps reached full speed, torque requirements would be excessive. The undesirable features of this starting were practically eliminated by arranging the controls to open the gates simultaneously with pump acceleration. This allowed for a more economical motor design that would meet the over-all pump characteristics and in addition, be within the requirements of the power system for full-voltage starting.

Home Foundry

THE making of metal castings in the home workshop is no longer beyond the reach of the home-workshop owner. Castings can now be made of aluminum, bronze, brass, pewter, silver, gold, copper, and other metals and alloys having similar melting points. They can be made by any one of several methods in simple or complicated designs. Two-part sand molds are used for the simplest castings and the lost-wax method is used for art objects of intricate design.

The lost-wax method of casting is the more complicated. It consists essentially of four steps: (1) Making a model of wax; (2) surrounding it with a refractory plaster cast; (3) melting out the wax from the cast; and (4) pouring bronze or other metal into the cavity formerly occupied by the wax. By following a few basic rules, very intricate and detailed castings can be made in nearly any shape or form.

Materials used for making castings can be almost any clean scrap metal such as copper, bronze, aluminum, etc., which can be purchased at used-metal markets or is usually on hand in the average home workshop. For bronze ingot, the ring gears of dismantled motorcars are very satisfactory.

Aluminum alloy is one of the best materials to work with. The castings come out of the mold bright and shiny and they are easily finished and polished. Used motor-car pistons are always available at low cost and are excellent material

Existing objects of glass, metal, wood, china, wax, etc. may be used as patterns. Inexpensive objects may be employed to create bronze copies many times the value of the original.

Patterns can be used over and over almost indefinitely, and if a large number of castings can be used from the same pattern, the time required for pattern-making is not important

Skill is rapidly acquired in the making of molds, selection of patterns, selection of metals, and in the handling and mixing of metals and alloys.

The necessary special equipment for making metal castings and forgings has been assembled into foundry sets of three sizes called Foundryettes, by the Kansas City Specialties Company, Kansas City, Mo. The sets have melting capacities of $1^1/_2$ lb to 6 lb, and allow the making of bronze castings of these gross weights. The three sets are essentially the same except for size. They operate on domestic gas and electric service, both being required for operation. The gas supplies the heat and the electric motor drives the air supply into the furnace to burn the gas.

The equipment included is as follows: (1) Gas furnace with blower; (2) fire-clay crucibles; (3) tongs; (4) molding flasks; (5) foundry graphite; (6) molding sand; (7) refractory furnace lid; (8) insulating lid; (9) instructions for use; (10) silica-mold parting dust.

The blower is a high-speed universal type and will operate on 110-volt, 60-cycle, 50-cycle, 25-cycle or direct current. It produces a very hot flame and will melt the metals quickly. The furnace operates on natural gas, coal gas, water gas, butane,

propane, or acetylene gas. The large furnace, starting cold, will melt a full 6-lb crucible of bronze in less than 40 min. Aluminum melts in less than 6 min.

The making of metal castings has an almost unlimited field of usefulness. Inventors and researchers will find that the casting of a machine part of a particular material and having a certain shape and size can be done quickly for a first trial. If a revision in design is needed, the revision can be made immediately instead of waiting for days or weeks for service through a commercial foundry.

Heat-treating, casehardening of steel, and experimentation at temperatures as high as 2400 F can also be performed with the equipment.

Standardized Fractional-Horsepower Motors

A NEW program of standardization for fractional-horsepower motors, designed to reduce production costs, insure efficiency and proper application in use, and result in long-term savings to customers, was announced by members of the Motor and Generator Section of the National Electrical Manufacturers Association at a press conference held in the Hotel St. Regis, New York, N. Y., Sept. 10, 1946.

Due to the increasing number of uses for small motors in household appliances and in an expanding variety of industrial applications, the new N.E.M.A. standards are of importance to allied manufacturing groups, as well as to application engineers, electrical contractors, power suppliers, and others in appraising motor performance in terms of name-plate rating and motor application.

The new standards provide specific definitions of motor rating and performance in co-ordinated terms of horsepower rating, speed, breakdown torque, and service factor. In formulating the new standards, the motor manufacturers felt that a clearly defined and generally accepted method of evaluating motor performance was essential in order to assure intelligent design, manufacture, and use of small power motors. The fundamental points covered in the standards include not only this new basis of rating, but also previously standardized locked rotor or starting currents of motors. It was emphasized that this was but the first phase in the new program of standardization, and would be followed later this year by other items of standardization such as dimensions, and application standards for hermetically sealed motors, belt-drive refrigeration compressor motors, washing-machine, stoker, oil-burner, belted fan and blower motors, shaft-mounted fans and blowers, cellar drainer, gasoline-pump, and jet-pump motors.

The standards will thus be of major interest to a wide range of users who may as a result be sure than the stamping on the motor name plate is an accurate designation of the article he is purchasing and will thus obtain increased return on motor investments through proper application, freedom from motor trouble, and longer motor life. As a result of better standard definitions, the machinery or appliance manufacturer, for example, can obtain proper motors from all suppliers without having to go through exhaustive engineering tests for each application or make of motor. This is also important from the standpoint of the ultimate purchaser of machines or applicances who has to make a sizable investment and expects performance and long life from the appliance.

Careful attention was given to factors which would permit selection of proper control equipment and wiring. Effort has also been made to define the standards in terms which would afford maximum freedom in design progress.

Protective Metal Coating

A TEMPORARY protective coating for metal parts developed by the Germans is described in a report made by the U. S. Naval Technical Mission in Europe.

The coating is composed of a mixture of wool fat, chinawood oil, natural resin, white spirits, and a soluble dye. It can be applied with an ordinary paint brush, it dries quickly, and it can be removed by washing with gasoline.

A German chemist stated that the coating was effective against rust, corrosion, and salt water, and that it would not melt when exposed to the direct rays of the sun. He claimed that it was particularly useful for the protection of metal parts during shipment.

The report (PB-22825) can be purchased from the Office of the Publication Board, Washington 25, D. C.

New Plane Launcher

A LINEAR electric motor more than a quarter of a mile long is the latest method devised for launching jet-propelled and robot planes and heavy bombers from shipboard or small landing fields without the initial impact of conventional catapults. This new device, called the electropult, was designed and built by engineers of the Westinghouse Electric Corporation for the United States Navy.

The electropult is essentially a huge electric motor laid out flat. The 1382-ft track corresponds to the rotor of a conventional machine and a small shuttle car which runs along it acts as the stator. In operation, a plane is hitched to the shuttle car which speeds down the track and tows the plane into the air. In recent demonstrations at the Naval Air Test Center, Patuxent River, Md., the electropult launched a jet-propelled plane at 116 mph in 4.1 sec after a run of only 340 ft. Unassisted, the plane would have required a run of about 2000 ft for the takeoff. Running free, without load, the shuttle car has built up a speed of 226 mph in slightly less than 500 ft.

Two electropults have been built for the Navy, the first installed at Mustin Field, Philadelphia, Pa., and the other at the Patuxent River Base. The latter is the more advanced model although both are fundamentally the same. At Patuxent

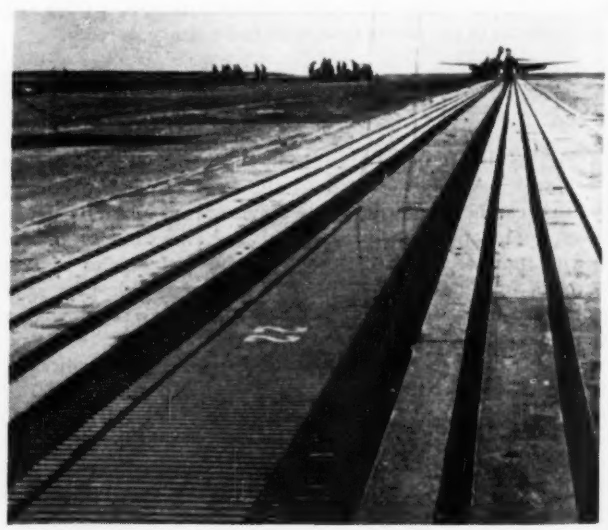


FIG. 11 LINEAR MOTOR TRACK OF THE ELECTROPULT FOR ASSISTING AIRCRAFT TAKEOFF

FIG. 12 NAVAL MECHANICS HITCH A JET-PROPELLED PLANE TO SHUTTLE CAR FOR LAUNCHING.

River the launcher is installed on a 2800-ft concrete runway, 100 ft wide. The track is mounted flush with this runway above a concrete trench which contains the copper bus bars that carry current to the motor. Sunk into the concrete on both sides of the track are rails to carry the shuttle car.

The shuttle car itself is $11^1/_2$ ft long, $3^1/_2$ ft wide, and extends only 5 in. above the track. To harness the plane to the car a bridle of steel cable is used. The plane rides along the track on its own wheels and when flying speed is reached the car is stopped, the bridle drops off, and the plane takes to the air.

The power supply for the electropult is housed in a sunken concrete vault beside the runway. A Pratt & Whitney 1100-hp aircraft engine starts the cycle. This engine drives a direct-current generator which is connected to a motor. This motor in turn is connected to an alternating-current generator and a 24-ton flywheel. The flywheel develops a tremendous amount of kinetic energy when accelerated to full speed of 1500 rpm. It is this energy stored in the flywheel that drives the alternating-current generator which supplies 12,000 kw of electricity to the electropult during the few seconds it takes to launch a plane.

Designs have already been completed for an electropult capable of launching the largest existing air liners at 120 mph with a takeoff run of 500 ft. Such air liners now need a run of about 4000 ft to accelerate to flying speed. Maximum acceleration would be about one g which would be built up during the first two seconds of the takeoff run. This means that a passenger would be pressed back into his seat by a force about equal to his own weight.

Other possibilities for the electropults besides aircraft carriers are floating airports or seadromes, barge-type airports on city water fronts, mid-city airports, and revival of outgrown airports.

Aluminum Refrigerator Car

AN aluminum refrigerator car recently built by the Illinois Central Railroad makes extensive use of aluminum, of fiberglas insulation, and of forced-air circulation. Through the use of collapsible bulkheads it will double in service as needed, with added space for ordinary merchandise boxcar purposes, and it can be heated as well as cooled. The saving in net weight will be some 14,000 lb or nearly 25 per cent of the weight of the usual refrigerator car.

In addition to improved riding qualities, (the car is cradled on springs and capable of traveling at speeds exceeding 60 mph) the car is expected to offer temperatures low enough for the efficient transportation of deep-freeze foods.

Correction

THE three propane-fired, apron conveyer-type forging furnaces described in the item, "18,000-Ton Forging Press," MECHANICAL ENGINEERING, September, 1946, pages 821–822, were designed and built by R-S Products Corporation, Philadelphia, Pa. This fact was omitted from the review due to an error.

Forgotten People

(*Continued from page 976*)

usually discussed. His discussion of top management personalities and policies in creating employee dissatisfaction, is highly satisfying.

Roethlisberger's "The Foreman: Master and Victim of Double Talk" is reprinted from the Harvard Business Review and, if you didn't see it there, it is certainly well worth reading. The foreman once a forgotten man among forgotten people has now become a "problem." If there are questions for anyone as to why the problem of the foreman is becoming a headache to management now, many answers may be found here.

Golden and Ruttenberg's "Motives for Union Membership" employing the device of highly readable anecdotes, places emphasis on something which too many of us tend to forget, that "workers organize into labor unions not alone for economic motives, but for equally compelling psychological and social ones."

McGregor's article on "The Conditions of Effective Leadership" is a rather more systematic approach to a problem which has been tackled many times by many people. It provides a frame of reference into which many of the often contradictory rules of thumb may be fitted with increased understanding.

The article on "A Method for Training Foremen" by John French demonstrates through the use of stenographic records the workings of a new method of training foremen to handle people. Although the method may appear rather startling, it is merely an attempt to employ in a new field the oldest method of training. If you want to teach someone to throw a ball you have them try throwing it and talk about their attempts, and then try again. Similarly a foreman may be trained to handle people by setting up a situation which is at once artificial and real in which he tries handling a problem, talks about it, and tries again. Worth reading about at least.

For those who have questions about the use or feasibility of counseling in the industry there is a section composed of our articles devoted to "Facilitating Adjustments through the Counseling Method."

To quote from the preface "It remains to be said that our knowledge of all the subjects discussed is still fragmentary and in an early stage of development. There are no final 'answers' to the questions and problems raised, but we have here not only a basis for further thinking and research but the exposition of a substantial development in the management of the human factor which progressive executives can utilize to good advantage."

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

A Marine Gas-Turbine Plant

COMMENT BY ALF LYSHOLM[1]

The following is a short summary of the writer's early work in connection with the gas turbine, which finally led up to the gas-turbine plant being discussed currently by the Society.[2,3]

In 1929, when I started to consider the gas turbine seriously, this prime mover was considered utopian it being before the metallurgists developed materials with excellent properties at extreme temperatures. Some preliminary investigations made by myself indicated, however, that this opinion was entirely wrong and that a general solution of the gas-turbine problem was within reach, even using materials available at that time.

The solution I had in mind was to use turbines, with the highest possible thermodynamic efficiency and limit the stresses at the turbine inlet to about 4000 to 6000 psi, which at that time restricted the temperature of the driving medium to 1000 F for steels of martensitic type and to 1200 F for austenitic steels. These requirements could be met by the Ljungstrom radial-flow double-rotation turbine.

An efficiency of 88 per cent after the control valve had already been obtained with a back-pressure turbine of that type, and, as it was intended to use an arrangement without valve control, this value would correspond to the total turbine efficiency.

Extensive theoretical investigation made by the Ljungstrom Turbine Company under my direction gave the result that an efficiency of about 30 per cent could be predicted at a temperature of 1000 F for the intercooling reheat cycle incorporating a good regenerator and about 20 per cent for the simple cycle without regenerator and at 1400 F. Naturally, only a short life could be expected at 1400 F but possibly sufficient to allow overload of an airplane turbine.

The results were so favorable that it was considered possible to build a lightweight unit without making a more conservative turbine as a first step. Such a lightweight turbine laid out for 800 hp at 100 psi pressure was designed and built in collaboration with A. B. Bofors, Sweden, and tested in 1935.

Fig. 1 of this comment shows an exterior view of this set. The turbine, of the double-rotation Ljungstrom type, is arranged in the middle. The air is taken in at the left-hand side and is compressed by three low-pressure centrifugal-compressor wheels driven by the left-hand side of the turbine, which also delivers useful power. The air then passes around the turbine to the high-pressure part of the compressor which consists of eight compressor wheels driven by the other side of the turbine. No useful power is delivered by this part of the turbine.

From the outlet scroll of the last compressor stage, the air passes through pipes to the combustion chamber, where fuel is injected and burned. The combustion gases then pass through pipes to the turbine, these pipes being jacketed by comparatively cool air to decrease the wall temperature. In the test-bed arrangement, the turbine was started by means of a single-stage steam turbine, which drives the high-pressure part of the compressor through the medium of a clutch.

In the tests, a maximum thermal efficiency of about 15 per cent was obtained at an admission temperature of about 1150 F, and a pressure of about 70 psia. This figure was encouraging, especially as all parts exposed to the highest temperature operated satisfactorily, even at peak temperatures of 1400 F.

On the other hand, the lightweight construction caused many troubles due to distortion, particularly in the case of the dummy pistons, which seized several times. Further, the pumping in the compressor could not be overcome, particularly at starting and upon sudden changes in load. Evidently a centrifugal compressor can be so designed that its sensitivity to pumping is less than was experienced in that case; but the troubles were so marked that I considered it essential, for the successful operation of a variable-load gas turbine, to use a compressor free from pumping.

This led to the development of the Lysholm compressor which, in combination with high-efficiency low-stressed turbines, has been used in the present plant.[2]

AUTHOR'S CLOSURE

The authors wish to thank Mr. Lysholm for his illuminating presentation of

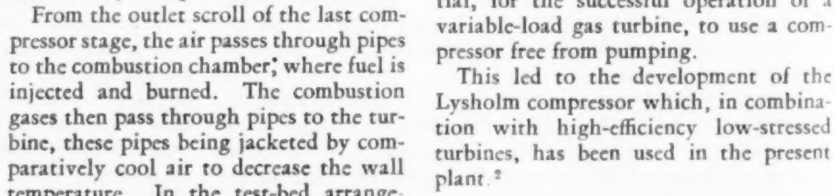


FIG. 1 LIGHTWEIGHT GAS TURBINE OF DOUBLE-ROTATION LJUNGSTROM TYPE

[1] Consulting Engineer, Stockholm, Sweden.

[2] "A Marine Gas Turbine," by A. T. Scott, R. B. Smith, and C. R. Soderberg.

[3] "Fundamentals of the Elliott-Lysholm Compressor," by W. A. Wilson and J. W. Crocker, MECHANICAL ENGINEERING, vol. 68, 1946, pp. 514–518.

the historical background for the development of the Elliott-Lysholm compressor.

One of the most striking features of the performance data presented in the paper is the tremendous range of stable operation achieved by this compressor, and it is obvious that Mr. Lysholm's objective of a compressor suitable for application to a variable-load gas turbine has been fully achieved.

W. A. Wilson.[4]
J. W. Crocker.[4]

Arc Welding

To the Editor:

Arc welding has been of decisive importance to America. Arc welding did more than most other manufacturing processes in the producing of the tools of war during World War II. Arc welding has produced a record for reliability in billions of welds, made over many years, that is unmatched by any other manufacturing process, yet arc welding is being attacked in a way which is tremendously handicapping its application and promises still more to interfere with its future use.

This attack is aimed not at the process, as such. It is obvious such tactics would fail. The attack consists in throwing suspicion on the process by writing into specifications expensive and impractical tests which have little to do with the excellence of the weld. Most of them have to do with infinitesimal variations of no possible importance but of great cost. The attack has already eliminated the economic use in many proper applications. If continued, it will soon eliminate many others.

We see, for instance, the ruling that welds must be x-rayed, which increases the cost by several times, yet the commercially welded joint is always of greater strength than the parent metal and is tremendously stronger than any riveted joint, where x-raying never has been suggested.

We see riveted joints which are made tight by calking. This process is accepted without question. The resulting undercut is enormous, yet a welding undercut that is infinitesimal is frequently made the reason for rejection of welds.

We see welds chipped out, rewelded, and welded vessels rejected because of trifling defects such as infinitesimal porosity either on the surface or beneath, yet parent metal in the same structure with defects much greater and whose weakening effect would be tremendously more serious, are accepted without question.

We see welding-electrode specifications being written which enormously increase the cost of production with no increase in either the reliability or in the excellence of electrodes. Rivets have no such test to handicap them.

While welding electrode is tested in every conceivable and nonsensical way, no one suggests any test on a rivet, yet the riveted joint is always the weakest spot in any structure. This is never true of a full-sized welded joint.

Much time and expense is used in testing electrode deposit to make sure it has great ductility and the weld is rejected if the ductility is low, yet riveted joints have no elongation and are accepted without question.

The contour of the deposit of a weld is a matter of very close inspection, yet no one examines the contour of any rivet or the hole it only partially fills.

All insured vessels must have their welds x-rayed and any weld is rejected if any infinitesimal defect is found, yet no one x-rays a riveted joint nor rejects it because of the voids between the rivets and the rivet holes which are known to be always present.

Because of the higher elastic limit of the weld metal, there is no load that can be put on a welded structure in which the weld is of equal or greater section than the parent metal which can affect the weld in any possible way until great distortion of the rest of the structure has taken place. Such distortion would make that structure valueless for its intended purpose, yet all this testing and rejecting just listed is made mandatory in many welded structures—never in riveted structures.

Further instances of the same kind can be cited by the score. The examples shown are sufficient for the author's purpose.

Welding over the years has done a more reliable job than the rivets it has replaced. That record is conclusive. The engineering profession, which relies so completely on welding in so many cases, must recognize and resist this studied attempt to eliminate the arc-welding process. The attack has already eliminated the economic use of welding in many structures. The success of such an attack on this tremendously valuable method is neither good advertising for the engineering profession nor good ethics for those involved in the attack. It is time we dealt with reality.

J. F. Lincoln.[5]

[4] Research and Development Department, Elliott Company, Jeannette, Pa. Members A.S.M.E.

[5] President, The Lincoln Electric Company, Cleveland, Ohio. Mem. A.S.M.E.

Construction Materials in the Petroleum Industry

Comment by I. A. Rohrig[6]

This paper[7] is of interest to the power industry as well as to the petroleum industry because many of the high-temperature materials discussed are used in both industries, and many of the high-temperature applications and problems are parallel.

A common material of construction used in both the petroleum and the power industry is carbon - 0.50 per cent molybdenum steel. Approximately 3 years ago a serious difficulty was discovered in the power industry in connection with the use of such steel in the welded condition. It was found that as a result of long-time service at temperatures in the vicinity of 900 to 1000 F, the combined carbon in the steel changed to free carbon or graphite, and that the graphite tended to precipitate principally in the heat-affected areas adjacent to welded joints.

When in an advanced stage, graphitization has been found to result in a serious decrease in the ductility and shock resistance of welded joints. Numerous examples of graphitization, in various stages of development, have been found at welded joints in high-temperature steam lines constructed of medium-carbon and carbon-molybdenum steel. Study of the problem has shown that graphitization appears to be associated with the amount of aluminum used in the deoxidation of the steel. Steels deoxidized with more than $^1/_2$ lb of aluminum per ton graphitize more readily than steels that have been treated with smaller amounts of aluminum. Although a considerable tonnage of carbon-molybdenum steel is in use in the petroleum industry at temperatures at which graphitization is known to occur, there has been no report, from that industry, of the occurrence of graphitization in association with welded joints.

With respect to high-temperature bolting materials, the author's suggestion that chromium-nickel materials would be

[6] Research Department, The Detroit Edison Company, Detroit, Mich.

[7] "Materials of Construction in the Petroleum Industry," by T. McLean Jasper, Mechanical Engineering, vol. 68, 1946, pp. 423–424 and 431.

satisfactory should be accepted with reservations. It has been found that pearlitic and martensitic chromium-nickel materials when exposed to stress at high temperature become brittle and are subject to failure as a result of strainage embrittlement. Satisfactory ductility can be restored to embrittled bolts by heating at 1100 F for 5 hr followed by oil-quenching. Various modifications of this type of heat-treatment would be equally satisfactory. The occurrence of such brittleness is not limited to chromium-nickel steels, but it appears to occur most readily in steels of that type with the result that chrome-moly, chrome-moly-vanadium and other bolting materials are widely used for applications at high temperature.

AUTHOR'S CLOSURE

The author is sure that Mr. Rohrig's remarks are correctly representative of the data published on tube graphitization. However, until the facts on graphitization in steel are known more fully, it is no use blaming carbon or carbon-molybdenum steels as being the fundamental cause of the trouble. In the malleabilization of cast iron we desire graphitization, and we know a considerable amount as to what to avoid in its chemical composition so that we may accomplish the most desirable effect. For steels to operate at high temperatures it is very probable that to add some of the elements, which we avoid for malleable cast iron, to our steels is a logical step, providing it is done with proper regard to other factors.

With reference to bolting materials for high-temperature operation, this is another highly controversial problem. Whereas molybdenum is a recommended element here and without blame, it undoubtedly is also blameless in the case of steel tubes for causing graphitization which was also associated with brittleness in these tubes.

This brings us to the point of considering what need exists for avoiding brittleness in structures. Our spring steels are essentially brittle, according to the generally accepted methods for measuring this quality. However, we use such brittle steels almost exclusively for absorbing large repeated shocks.

We need ductility mostly to cold-fabricate with. After this is accomplished, its need is almost dormant in service. We ask for this quality in steel mostly on the basis of what we can get in good steelmaking practice without paying too much for it.

The brittleness brought about by caustic attack of grain boundaries is undesirable. We avoid this kind of embrittling action as much as possible by stabilizing the steel. The stabilized steel may be no more ductile than the unstabilized steel when made and as measured by the usual methods.

We strain-harden steel by repeated overstressing above the yield point and then blame the steelmaker for it. This is particularly true in bolting steels where used in repeated operations in bolting-up and unbolting.

T. McLEAN JASPER[8].

[8] John Thompson Engineering Co. Ltd., Wolverhampton, England. Mem. A.S.M.E.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Job Evaluation Methods

Job Evaluation Methods. By Charles W. Lytle. Ronald Press, New York, N. Y., 1946. Cloth, 6 × 9 in., 329 pp., 117 Figs., $6.

REVIEWED BY R. S. SHENK.[1]

THE book under review, "Job Evaluation Methods," by Prof. Charles W. Lytle, is a comprehensive compilation of existing literature and practices on all phases of base-rate determination.

While the author advances few, if any, original ideas and adds little to the existing knowledge of the subject, nevertheless he has prepared an excellent compilation of existing plans and techniques which should prove of definite value to anyone engaged in wage-administration work, as well as to teachers of the subject. Unlike the majority of other books and articles dealing with job evaluation, Professor Lytle's book contents itself with explaining the fundamentals involved in the various methods and techniques. He deals with each phase of the subject individually, explaining how it is treated in the different plans in use today. The author avoids making definite recommendations as to what plan or elements of plans are the most satisfactory, but his analysis does aid in selecting the better plan for an existing situation.

In including the number of different methods and techniques along with numerous quotes from authorities on the subject, the author sacrifices conciseness and may confuse readers who are not experienced in job-evaluation work.

Merit-rating plans and techniques are included on the same basis as are those of job evaluation.

A listing and explanation on government regulations on wages and salaries are a part of the book. Their value is questionable in that they are only up to date at the time of publication. Nevertheless this section does serve to indicate how such regulations are tied in with the development of company policies governing wages and salaries.

The whole matter of compensation, particularly equal compensation for equal service being emphasized by many labor unions, is forcing management generally to realize the advantages of a sound job-evaluation program. The availability in one publication of information on numerous plans and techniques along with the opinion of a number of authorities in the field should be a definite help to those who are seeking to establish a job-evaluation plan of their own.

[1] Armstrong Cork Company, Lancaster, Pa.

Books Received in Library

AIRPORT PLANNING. By C. Froesch and W. Prokosch. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1946. Cloth, $8^1/_2 \times 11^1/_4$ in., 250 pp., illus., diagrams, charts, maps, tables, $7. Airport problems are clearly and concisely analyzed from a fundamental and functional viewpoint. The purposes of the book are: (1) To indicate the proper relationship of landing facilities to communities or regions they are to serve; (2) to analyze the characteristics of aircraft which affect the planning and design of these facilities; (3) to effect a proper balance between the airfield and buildings. Practical and detailed consideration is also given to airfield construction and lighting, building design, hangar design, and the establishment and operation of special services.

Aminoplastes (Matériaux de Synthèse.) By P. Talet, préface de J. Duclaux. Dunod, Paris, France, 1946. Paper, $5^1/_2 \times 9$ in., 235 pp., diagrams, charts, tables, 280 fr. Following a statement of the general theory comes a brief description of the raw materials, urea, and formaldehyde. The methods of formation are next dealt with, covering the condensation, dehydration, and hardening processes. The preparation of molding powders and the methods of molding are dealt with in some detail. Several brief chapters take up various uses such as for glues, varnishes, and other coatings, and impregnation. Finally, some fifty pages are devoted to various modifications: the replacement of urea by other nitrogen compounds, and similar treatments.

Analytic Geometry and Calculus. By H. B. Phillips. Second edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1946. Cloth, $5^1/_2 \times 8^1/_2$ in., 504 pp., diagrams, tables, $4.50. The object of this textbook is to present analytical geometry and calculus in the form and order in which these subjects are required for courses in science and engineering. Consequently, after a mere introduction of graphical representation, the first three chapters provide a complete elementary course in the fundamentals of the calculus, including integration as a process of summation. The succeeding chapters develop both subjects in a simple and logical manner.

Atomic Energy in Cosmic and Human Life. Fifty Years of Radioactivity. By G. Gamow. University Press, Cambridge, England; The Macmillan Company, New York, N. Y., 1946. Cloth, $5^1/_4 \times 8^1/_4$ in., 161 pp., illus., diagrams, charts, tables, $3. In the first section the author takes up the question of what is atomic energy, and describes the modern alchemy by which atomic transformations are brought about. In the second section he describes the way in which these transformations are used and produced by and in the stars, with extremely high temperatures as the producing mechanism. The final section discusses the problem of how man can use atomic energy, utilizing the method of neutron multiplication and bombardment as described.

Atomic Spectra. By R. C. Johnson. Methuen & Co., Ltd., London, England, distributed by Chemical Publishing Co., Brooklyn, N. Y., 1946. Cloth, $4 \times 6^3/_4$ in., 120 pp., diagrams, charts, tables, $2. Following a brief introduction on the production of spectra, the book then discusses spectra of the hydrogen type, one electron revolving around a positive nucleus, and spectra of atoms with two or more electrons. The structure of atoms is considered and two chapters deal with the effect of special conditions and applied fields on spectral lines. The organization of the periodic table on the basis of the electronic structure of the elements is demonstrated, and spectroscopic instruments and procedures are described in the final chapter.

Automatic Weapons of the World. By M. M. Johnson, Jr., and C. T. Haven. William Morrow and Company, New York, N. Y., 1945. Cloth, $6 \times 9^1/_2$ in., 644 pp., illus., diagrams, woodcuts, tables, $7.50. Completely revised from the original edition, this treatise now covers all self-loading and self-fired weapons up to the 40 mm of the aircraft and antiaircraft types. The grouping by chapters is as follows: general principles; history and development; how to keep them firing (maintenance); employment in combat; and miscellaneous considerations. Summaries of technical information concerning weapons and ammunition, a five-page bibliography, and over 500 photographs and diagrams increase the practical value of this book.

Corrosion of Metals. By C. W. Borgmann, C. P. Larrabee, W. O. Binder, H. L. Burghoff, and E. H. Dix, Jr. American Society for Metals, Cleveland, Ohio, 1946. Fabrikoid, $6 \times 9^1/_4$ in., 181 pp., illus., charts, tables, $3. In this small volume are reprinted five lectures presented at the 1946 National Metal Congress. The separate titles are as follows: basic principles of metallic corrosion; effect of composition and environment on corrosion of iron and steel; corrosion-resistance of stainless steels and high-nickel alloys; copper and copper alloys in corrosive environments; corrosion of light metals (Al and Mg).

Crankshaft Design and Manufacture. By J. Smith. Whitehall Technical Press Ltd., London, S.W. 1, England, 1946. Cloth, $7 \times 9^3/_4$ in., 64 pp., diagrams, charts, tables, 12s 6d. The separate chapters of this book appeared originally as a series of articles in the British magazine, *Gas and Oil Power*. They cover crankshaft materials, proportions, and the calculation of dissensions, vibration and balancing, and specific shaft calculations. A special chapter is devoted to flexible couplings.

Diesel-Electric Locomotive. By C. F. Foell and M. E. Thompson. Diesel Publications, New York, N. Y. 1946. Cloth, $6 \times 9^1/_2$ in., 688 pp., illus., diagrams, charts, tables, $7, U. S. A.; $8, foreign. The early chapters of this book cover the history, development, advantages, and classification of Diesel-electric locomotives. The remainder of the book deals with the constructional, engineering, operational, and maintenance aspects of the subject in considerable detail and with many illustrative charts and diagrams. Two chapters of general engineering fundamentals are included, and Diesel-hydraulic and Diesel-mechanical locomotives are given brief consideration.

Elastomeric Engineering, describing the scientific process of manufacturing rubber units for the requirements of the Engineering & Shipbuilding Industries. Published by Andre Rubber Company Ltd., Hook Rise, Tolworth, Surrey, England. Second edition, 1945. Cloth, $7^1/_2 \times 10$ in., 168 pp., illus., diagrams, charts, tables, 1 guinea. The first four chapters are devoted to the properties, preparation, compounding, manufacture, and processing of natural and synthetic rubbers. The succeeding chapters describe the production of rubber-metal bonded units for various engineering applications. The properties of the rubber-metal bond are discussed, manufacturing processes and testing methods are described, and design procedure and calculations are given.

Engineering Mechanics. By S. Fairman and C. S. Cutshall. Second edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1946. Cloth, $5^3/_4 \times 9^1/_4$ in., 267 pp., diagrams, tables, $3. The object of this book is to provide a self-contained course in fundamental mechanics which can readily be covered in the usual time allotted to the subject. A knowledge of calculus and general physics is assumed, and no attempt is made to include material which may properly be deferred to advanced strength of materials. Special attention has been paid to arranging the subject matter in the most logical and effective order within the two main sections, statics and kinetics.

Engineer in Society. By J. Mills. D. Van Nostrand Co., Inc., New York, N. Y., 1946. Cloth, $5^1/_4 \times 8^1/_2$ in., 196 pp., $2.50. This group of essays, dealing with the relationship of scientists and engineers to the world society in which they function, covers a variety of topics: the importance and quality of aptitude tests; salaries of engineers and scientists; woman's part in engineering work; business executives and research; an over-all organization of scientists and engineers; and other thought-provoking ideas. The final set of six essays is concerned with the development of creative thought and better expression on the part of engineers in their writings.

Great Britain. Department of Scientific and Industrial Research. Atmospheric Pollution Research, Technical Paper No. 1. Atmospheric Pollution in Leicester. His Majesty's Stationery Office, London, England, 1945. Cloth, $6 \times 9^1/_2$ in., 164 pp., illus., diagrams, charts, tables, 3s. Obtainable from British Information Services, New York, N. Y., $.95. As a part of the program of research on atmospheric pollution of large towns, some 200,000 readings of gages, filters, and other apparatus were taken over a three-year period. The apparatus used is described with methods for accurate determinations. The results are summarized and discussed, and the practical aspects are emphasized with suggestions on smoke abatement, sulphur control, and town planning.

Heating and Ventilating for Architects and Builders. By R. K. Cornell. Paul Elek Publishers Ltd., London, E.C. 1, England, 1946. Cloth, $7^1/_4 \times 10$ in., 56 pp., illus., diagrams, charts, tables, 7s 6d. The first two chapters of this practical book present the fundamental principles and the calculation of heat losses and heat requirements. Chapter 3 contains the classification and comparison of heating and water-supply systems, the application of such apparatus, and water treatment. In chapter 4 will be found furnace control, the combustion of fuel, and running costs of systems. The final chapter deals with the types and operation of equipment.

Introduction to X-Ray Metallography. By A. Taylor with a foreword by Sir Lawrence Bragg. Chapman & Hall, London, England, 1945. Cloth, $6^1/_4 \times 10$ in., 400 pp., illus., diagrams, charts, tables, 36s. Chapter 1 discusses briefly the scope of x-ray analysis. The succeeding five chapters describe the apparatus for x-ray generation, and deal with the physics of x rays. Chapter 7 on the crystal structures of the metals introduces the series of chapters covering the application of x rays to certain aspects of metallurgy: the study of thermal equilibrium diagrams; measurement of grain size; determination of grain orientation; radiography and microradiography. There are numerous references to important articles, and an appendix of tabulated technical data.

Labor-Management Economics, a Basic Practical Summary. By W. V. Owen in collaboration with Stevenson, Jordan & Harrison, Inc., management engineers. Ronald Press Co., New York, N. Y., 1946. Cloth, $5^1/_4 \times 8^1/_4$ in., 121 pp., diagrams, cloth, $2. Part 1, on employer-employee economics, deals with management, production, risks, and costs on the employer's side of the question and with wages, labor economics, and unionism as more directly related to the employees' interests. It ends with a chapter on industrial relations in general. Part 2, the economic framework, is concerned with some of the economic forces, concepts, and relations that provide the economic mechanics for producing, marketing, and consuming goods.

Labor Problems. By W. V. Owen. Ronald Press Co., New York, N. Y., 1946. Cloth, $6 \times 9^1/_4$ in., 570 pp., diagrams, charts,

tables, $4.50. Intended to present a survey of the principles and problems of labor economics from a broad viewpoint, this book covers the subject in four main sections: the economic characteristics of labor and the nature of the labor market; the labor market in operation, including supply and demand, wages, hours, working conditions, and the mobility of labor; the control of the labor market exerted by the trade unions, the employer, and the state; and security in the labor market as affected by old age, unemployment, and time lost through strikes and disagreements.

Lincoln's Incentive System. By J. F. Lincoln. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1946. Cloth, $5^3/_4 \times 9$ in., 192 pp., illus., charts, $2. Incentive management, as outlined in this book, goes beyond the ordinary conceptions of incentive pay. It is a philosophy of industry and life, which starts with the needs of society and depends primarily for its success on the development in the individual of his latent abilities. It is not only a method of wage payment; it is an economic system. The book presents exact data and results of the application of this system, and shows how it can be put into effective use in a plant.

Principles of Business Organization. By W. R. Spriegel and E. C. Davies. Prentice-Hall, Inc., New York, N. Y., 1946. Cloth, $6 \times 9^1/_4$ in., 564 pp., illus., diagrams, charts, tables, $6.35. The material presented in this book is divided into the following major sections: Ownership and structural forms of a business enterprise; promotion and operation of an enterprise; financial considerations; accounts and records; the manufacturing function; the marketing function; personnel maintenance. Miscellaneous considerations such as business research, governmental controls, etc., are covered in a final section. Although an operating business is the central theme, much of the material would meet the requirements of other types of organizations.

Railroad for Tomorrow, 1960. By E. Hungerford. Limited first edition. Kalmbach Publishing Co., Milwaukee, Wis., November, 1945. Cloth, $6 \times 9^1/_4$ in., 323 pp., illus., tables, $5. The unification of the railroads of the United States into one system is the theme of this book. In semifictional style the author describes in detail the steps by which this was accomplished under the direction of one William Wiggins. A thorough historical treatment of American railroads to the present day is included, together with the hypothetical developments up to 1960, by which date the unification is presumed to be complete. The work is a well-reasoned and thought-provoking study for those interested in railroads and the transportation problem.

Reynolds' Number. By J. Jennings. Emmott & Co., Ltd., Manchester, England, 1946. Paper, $4^1/_2 \times 7^1/_4$ in., 20 pp., charts, tables, 1s. The object of this small pamphlet is to demonstrate clearly the meaning of the Reynolds Number, to examine its structure, explain its significance, and show how it may be calculated and utilized. The pamphlet should be useful to any one concerned with any of the varied applications of the science of fluid dynamics.

Rubber Red Book, Directory of the Rubber Industry, 1945 edition, fifth issue. *Rubber Age*, New York, N. Y., 1945. Cloth, $6 \times 9^1/_4$ in., 691 pp., illus., $5. This biennial directory lists the rubber manufacturers of the United States alphabetically, geographically, and by product. Classified lists of rubber machinery and equipment, rubber chemicals and compounding materials, fabrics and textiles, natural rubber and related materials are provided, with the names of manufacturers or suppliers. Supplementary lists of rubber derivatives, scrap-rubber dealers, consulting technologists, technical journals, and organizations are included. Synthetic rubbers are briefly considered.

Simplified Punch and Die Making. By J. Walker and C. C. Taylor. The Macmillan Co., New York, 1946. Cloth, $5^1/_2 \times 8^1/_2$ in., 235 pp., illus., diagrams, tables, $5.75. Each step in the design, construction, and operation of dies and punches is clearly and fully explained in this book for the use of those without previous experience. All important types of dies and punches used today are covered, with detailed information on specifications, materials, methods, etc. There is a glossary of shop terms.

Soap in Industry. By G. Leffingwell and M. Lesser. Chemical Publishing Co., Brooklyn, N. Y., 1946. Cloth, $5^1/_2 \times 8^3/_4$ in., 204 pp., tables, $4. Classified by industries, this book describes the utilization of soaps and soap-like products in manufacturing processes. The peculiar properties of soap which make its use possible for a variety of purposes are demonstrated, and a large number of practical formulas are given for specific purposes. Among the fields considered are construction, lubricants, mining and ore treating, oil production, plastics, road building and maintenance, rubber production, and textiles.

Surface Active Agents, Theoretical Aspects and Applications. By C. B. F. Young and K. W. Coons. Chemical Publishing Co., Brooklyn, N. Y., 1945. Cloth, $5^1/_2 \times 8^3/_4$ in., 381 pp., illus., diagrams, charts, tables, $6. Part 1 deals with the theoretical aspects of surface tension, methods for the determination of surface tension, and the structure of wetting agents, including a comprehensive 35-page list of wetting and other surface-active agents. Part 2 presents useful information concerning the origin and effect of surface-tension phenomena and their use in the following practice fields: emulsions, plating, cosmetics, leather, flotation, inks, textiles, cutting oils, foods, adhesives, lubrication, soldering, brazing, and welding.

Theory and Practice of Lime Manufacture, a collection of articles by V. J. Azbe, 1923–1946. Y. N. Rauert, St. Louis, Mo. Cloth, $8^1/_4 \times 11$ in., 423 pp., illus., diagrams, charts, tables, $8. This volume brings together 163 articles and papers, from various sources, by Victor J. Azbe, a consulting engineer of long standing in the combustion field. The articles are presented in chronological sequence from 1923 to 1946 and deal with a great variety of topics within, or relating to, the lime industry with which the author has been directly associated for a number of years. Reproductions of his patents on lime-burning machinery are appended.

Thin Films and Surfaces. By W. Lewis, published for Temple Press, Ltd., by English Universities Press, Ltd., Little Paul's House, London, E.C.4, England, 1946. Cloth, $5^1/_2 \times 8^3/_4$ in., 70 pp., illus., diagrams, tables, 15s. The structure of metal surfaces and of surface films (of oxide, etc.) is first considered, with special reference to the structure of thin films. The production of thin metallic films is next dealt with, followed by a section discussing the mechanical, optical, magnetic, and electrical properties of metallic films and surfaces. The last two chapters collect what information is relevant about the properties of aluminum, briefly summarize some comparative data for other metals, and refer to interesting applications of aluminum films and surfaces.

Time Study and Motion Economy With Procedures for Methods Improvement. By R. L. Morrow. Ronald Press Company, New York, N. Y., 1946. Cloth, $6 \times 9^1/_2$ in., 338 pp., illus., diagrams, charts, tables, $5. All procedures described in this book, with the exception of the new synthetic leveling, have been regularly used in practice. The author describes ways to study operations, take observations, and compute all necessary data. Charts, tables, and diagrams are extensively used to illustrate the methods and the kinds of records discussed in the text. The book is designed for the small plant as well as for the large plant.

Tinplate. By W. E. Hoare and E. S. Hedges. Edward Arnold & Co., London, England; Longmans, Green & Co., New York, N. Y., 1945. Cloth, $7^1/_4 \times 10$ in., 292 pp., illus., diagrams, charts, tables, $12. Beginning with an historical account, the book proceeds to cover the manufacture, uses, properties, structure, testing methods, and corrosion resistance of tinplate. The manufacturing processes are treated from a practical viewpoint, but the research background is indicated for recent developments. The fabrication of tinplate into its many final forms as containers, etc., is not dealt with in this book. There is a final chapter on electro-tinplate followed by a statistical appendix.

To-Morrow's Airliners, Airways, and Airports. By S. E. Veale. Pilot Press, Ltd., London, W.C.1, England, 1945. Cloth, $5^1/_2 \times 8^3/_4$ in., 337 pp., illus., diagrams, charts, tables, 15s. Covering a wide field, the author discusses a number of the technical, economic, social, and political problems connected with the future development of commercial air services. The four main parts deal respectively with the airplanes, both as machines and vehicles; with air lines, including operation and regulation; with the development of airports to handle the coming planes and traffic; and with the requirements and duties of jobs connected with air commerce. A supplementary map depicts the world's airlines, in operation and projected, as of 1939.

Why Smash Atoms? By A. K. Solomon. Harvard University Press, Cambridge, Mass., 1946. Cloth, $6 \times 9^1/_4$ in., 204 pp., illus., diagrams, $3. Laymen who wish to know how atoms are smashed and what possible uses may be foreseen will find this book of great interest. The story of atomic research during the last fifty years is reviewed, and the apparatus developed is described informally by one with firsthand experience. This edition contains three added chapters based on the Smyth report. The story is clear and authoritative and is illustrated by numerous drawings.

A.S.M.E. NEWS

And Notes on Other Engineering Societies

Tentative Program of A.S.M.E. 1946 Annual Meeting New York, N. Y., December 2–6, 1946

Headquarters, Hotel Pennsylvania

BECAUSE the United Nations Assembly will be in session only a few miles across the East River from Manhattan and because delegations from more than 50 countries of the world will be setting up shop in New York City, the 1946 Annual Meeting of The American Society of Mechanical Engineers at the Hotel Pennsylvania, December 2–6, 1946, will be held in a truly cosmopolitan atmosphere. Congested as the city will be, A.S.M.E. members have been assured hotel accommodations because of the farsighted planning of the Committee on Meetings and Program which has obtained a guarantee of 1000 rooms from 20 hotels and has set up a procedure for equitable distribution of the available rooms.

A.S.M.E. Housing Bureau

Some of the hotels have tied strings to their guarantee, such as advance deposits and a requirement that reservations begin Sunday, Dec. 1, and hence the Committee has set up an A.S.M.E. Housing Bureau to handle all requests for hotel accommodations. An application form for hotel reservations has been mailed to all members requesting specific information about individual preferences. While the questions may appear annoying, members, are urged to co-operate with the Bureau so that a maximum number of members can be accommodated. Such information as the date and time a member expects to arrive in the city will enable the Bureau to assign members, who have no objection to sharing a room with a fellow engineer, to large rooms accommodating more than one person.

All requests will be honored strictly in the order received. Requests should be mailed not to headquarters but to Miss Sylvia Peltonen, manager, Housing Bureau, The American Society of Mechanical Engineers, Room 1536, 233 Broadway, New York 7, N. Y. No request will be honored if received after Wednesday, Nov. 20, 1946.

Members who are accustomed to stay at a particular hotel need not use the services of the A.S.M.E. Housing Bureau, if they can secure accommodations by writing directly to the hotel of their choice.

Theme

The theme of the 1946 Annual Meeting will be "The Public Responsibility of the Engineer." Plans are being made to have a prominent speaker address the meeting on that subject during the general luncheon on Monday, Dec. 2.

Luncheons and Dinners

Interesting speakers have been engaged to speak at the daily luncheons and dinners planned for the meeting. On Tuesday, Dec. 3, Paul G. Hoffman, president, The Studebaker Corporation, recipient of the 1946 Gantt Gold Medal, will speak on "Outlook for Freedom." Air Commodore Frank Whittle, of the Royal Air Force, recipient of the 1946 Daniel Guggenheim Medal for Achievement in Aeronautics and father of jet propulsion, will speak on "Development of Turbo-Jet Engines" at the general luncheon Friday, Dec. 6. Philip Swain, editor of *Power*, will describe his experiences at the Bikini atom-bomb tests in a talk, "What Really Happened at Bikini—An Engineer's Interpretation."

Honorary Memberships

The Society will honor two of its distinguished fellows at the annual banquet on Wednesday, Dec. 4, when certificates of honorary membership will be presented to L. K. Sillcox and A. G. Christie.

1946 A.S.M.E. Medal

In addition to honors listed on page 918 of the October issue of MECHANICAL ENGINEERING, the A.S.M.E. Medal for 1946 will be conferred on Morris E. Leeds, chairman of board, Leeds and Northrup Company, Philadelphia, Pa., for his achievements in the de-

Fairchild Aerial Surveys, New York

MIDTOWN NEW YORK SHOWING SOME POINTS OF INTEREST FOR A.S.M.E. MEMBERS DURING THE 1946 ANNUAL MEETING

[These are: (1) Engineering Societies Building; (2) Times Square; (3) Pennsylvania Railroad Station; (4) Grand Central Station; (5) Grand Central Palace where the 1946 Power Show will be held; and (6) Pennsylvania Hotel, headquarters, A.S.M.E. 1946 Annual Meeting.]

Cushing, New York

ST. PAUL'S CHAPEL, OLDEST CHURCH IN NEW YORK, N. Y.

velopment of electric and temperature-measuring instruments.

The American Rocket Society

The American Rocket Society, which was officially affiliated with the A.S.M.E. in 1945, will participate in several technical sessions of the meeting. On Dec. 6, C. N. Hickman, Bell Telephone Laboratory, will address a joint A.S.M.E.-A.R.S. dinner on, "Rocket Projectile Development." His talk will be illustrated with films and slides. Eight other papers covering recent rocket development will be presented by the A.R.S.

Preprints of Papers

A considerable number of papers to be presented at the Annual Meeting are now available in preprint form for distribution.

Charges for preprints ordered by mail range from 15 to 30 cents a copy, depending on the number of pages (10 to 25 cents if purchased at the publication booth). In ordering papers it is suggested that a minimum of 15 cents per copy be forwarded for each preprinted paper. If remittance is insufficient, bill will be rendered for the difference.

Please order by number and send order with remittance to A.S.M.E. Headquarters, Publication Sales, 29 West 39th Street, New York 18, N. Y.

Preprinted papers available at time of going to press are listed below:

Corrosion Is No Accident, by Herman E. Smith, No. 46-A-1

Correction for Heat-Conduction Through Longitudinal-Baffle of Heat Exchanger, by A. W. Whistler, No. 46-A-2

Determination of the Natural Frequencies of the Bending Vibrations of Beams, by A. I. Bellin, No. 46-A-3

The Manufacture of Wood-Cased Pencils, by Charles R. Nichols, Jr., No. 46-A-4

Shell-Side Coefficients of Heat Transfer in a Baffled Heat Exchanger, by H. S. Gardner and Irving Siller, No. 46-A-5

Maximum Performance of Helical Springs, by Erle I. Shobert, II, No. 46-A-6

The Coefficients of Thermal Expansion of Wood and Wood Products, by R. C. Weatherwax and A. J. Stamm, No. 46-A-7

Effect of Varying Relief Angles When Face-Milling Cast Iron With Sintered-Carbide-Tipped Cutters, by O. W. Boston and W. W. Gilbert, No. 46-A-8

Kinematics of Disk Cam and Flat Follower, by Allan H. Candee, No. 46-A-9

Production and Use of Hydrogen Peroxide by the Germans During World War II, by Logan McKee, No. 46-A-10

Corrosion and Embrittlement of Boiler Metal at 1350 Lb Operating Pressure, by L. E. Hankison and M. D. Baker, No. 46-A-11

Experiences With Internal-Boiler-Surface Corrosion in 1450 Lb Open-Pass Boilers at West End Station of the Cincinnati Gas and Electric Company, by E. H. Mitsch and B. J. Yeager, No. 46-A-12

Wood-to-Metal Adhesives, by Thomas D. Perry, No. 46-A-13

Model Tests of Granby Pumps, by B. L. VanderBoegh, No. 46-A-14

Hydro in Wartime Germany, by A. Hoefle, No. 46-A-15

Investigation of Acid Attack on Boilers and the Effect of Repeated Acid Cleaning of the Metal, by H. C. Farmer, No. 46-A-16

Wall-Tube Corrosion in Steam-Generating Equipment Operating Around 1300 Psi, by F. G. Straub, No. 46-A-17

The Horizontal Cyclone Burner, by A. E. Grunert, L. Skog, and L. S. Wilcoxson, No. 46-A-18

Analysis of Equipment Weight Reduction in Modern Railway Cars, by H. H. Hanft, No. 46-A-19

The Hardened and Tempered Microstructure of High-Speed Tool Steel as a Factor in Tool Performance, by W. H. Wooding, No. 46-A-20

Influence of Postweld Heat-Treatment on Graphitization, by I. A. Rohrig and Arthur McCutchan, No. 46-A-21

Forced Torsional Vibrations, by J. P. Den Hartog and J. P. Li, No. 46-A-22

Orthogonal Functions Used in the Solution of Linear Difference Problems, by Stanley U. Benscoter, No. 46-A-23

Control and Prediction of Pulsation of Frequency in a Duct System, by Wm. R. Heath and W. R. Elliot, No. 46-A-24

The Theory of Curved Beams, by Gilbert C. Best, No. 46-A-25

A Report on Graphitization Studies in Philadelphia Electric Company's High Temperature Welded Piping, by E. L. Hopping and A. E. White, No. 46-A-27

Measurement of the Viscosity and Shear Elasticity of Liquids by Means of a Torsionally Vibrating Crystal, by W. P. Mason, No. 46-A-28

Use of Electric Gaging Equipment in Machine Design, by P. E. Nokes and E. G. Carr, No. 46-A-29

Women's Program

The Metropolitan Section of the Woman's Auxiliary to the A.S.M.E. has arranged an interesting program for the A.S.M.E. women and guests planning to attend the 1946 Annual Meeting. The program will commence with a tea dance on Monday afternoon, Dec. 2. Tuesday, Dec. 3, will be devoted to an all-day trip to the United Nations Headquarters at Flushing and Lake Success, N. Y.

The Annual Luncheon of the Woman's Auxiliary will be held on Wednesday, Dec. 4, at the Engineering Woman's Club, New York, N. Y. On Thursday morning, Dec. 5, there will be a boat trip to the Statue of Liberty. This will be followed in the afternoon by a theater party and a conducted tour of the Museum of Natural History. Friday, Dec. 6, will be given to shopping trips during which members of the Metropolitan Section will act as escorts.

SUNDAY, DECEMBER 1

9:30 a.m.

Meeting of Executive Committee of Council

12:30 p.m.

Council Luncheon

2:00 p.m.

Meeting of Council

5:00 p.m.

Meeting of Executive Committee of Council

7:00 p.m.

Meeting of Council

MONDAY, DECEMBER 2

9:30 a.m.

Meeting of Council

Applied Mechanics (I)

On the Collapse of a Hemispherical Cavity Seated on a Surface, by H. P. Oza, Massachusetts Institute of Technology, Cambridge, Mass.

The Study of Fluid Flow by the Use of Polarized Light, by R. Weller

Geometrical and Metallurgical Changes in Steel Surfaces Under Conditions of Boundary Lubrication, by B. W. Sakmann, production

Registration Fee for Non-Members at the 1946 Annual Meeting

There will be a registration fee of $2 for nonmembers attending the 1946 Annual Meeting. For nonmembers wishing to attend just one session (except evening sessions or meal meetings) the fee will be $1. This is in accordance with the ruling of the Standing Committee on Meetings and Program.

Members wishing to bring nonmember guests (male) may avoid this fee by writing to the Secretary of the Society before November 15 asking for a guest-attendance card for the Annual Meeting. The card, upon presentation by a guest, will be accepted in lieu of the registration fee. Guests are limited to *two per member*.

department, Carter Oil Company, Tulsa, Okla.

Aviation (I)

Passenger Comfort

Acoustical Materials and Acoustical Treatments for Aircraft, by R. H. Nichols, Jr., Bell Telephone Laboratories, Murray Hill, N. J.

Development Procedure for Aircraft Combustion Heaters, by Paul Manor, design engineer, Janitrol engineering department, Surface Combustion Corporation, Toledo, Ohio

Industrial Instruments and Regulators (I)

Ship Stabilization With Activated Tanks, by N. Minorsky, David Taylor Model Basin, Washington, D. C.

Graphic Representation and Analysis of Automatic-Control Terminology, by J. G. Horn, development engineer, The Brown Instrument Company, Philadelphia, Pa.

Rubber and Plastics (I)

Practical Aspects of Design of Structural Rubber, by E. E. Blaurock, U. S. Rubber Company, Detroit, Mich.

Vibration Damping With Rubber Mountings, by Robert Lewis, M-B Manufacturing Company, Inc., New Haven, Conn.

Laboratory Testing of Rubber Torsion Springs, by D. H. Cornell and J. R. Beatty, B. F. Goodrich Company, Akron, Ohio

Advances in Rubber During 1946, by E. F. Riesing, chief automotive engineer, Industrial Products Co., Inc., Detroit, Mich.

Consulting Engineering

Information in final program

Research Committees on Metal Cutting Data and Bibliography and Cutting Fluids (I)—Production Engineering (I)

Information in final program

12:15 p.m.

Keynote Luncheon

Speaker: Carl Hinshaw, member of Congress, House of Representatives, Washington, D. C.

Subject: The Public Responsibility of the Engineer

The luncheon will be followed by a session at which prominent engineers will speak.

2:30 p.m.

Meeting of Council

4:00 p.m.

Business Meeting

6:00 p.m. Industrial Instruments and Regulators Division Dinner

7:00 p.m.

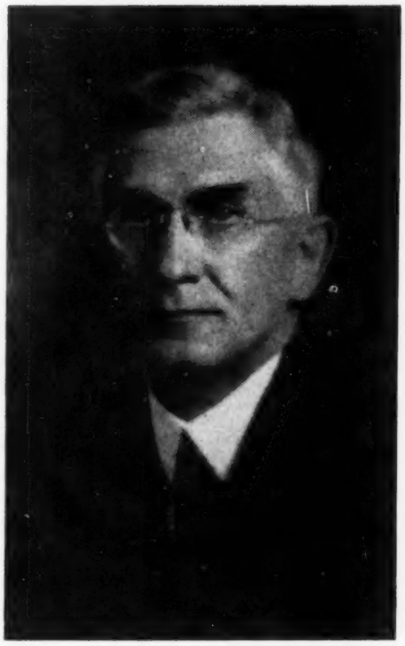
Council Dinner

8:15 p.m.

Management (I)

Symposium: A Basic National Labor Policy

Chairman: W. H. Davis, formerly of War Labor Board



LEWIS K. SILLCOX, HONORARY MEMBER-ELECT, A.S.M.E.

Speakers for Management: Herman W. Steinkraus, president, Bridgeport Brass Co., Bridgeport, Conn., and Lee H. Hill, publisher, *Electrical World*, McGraw-Hill Publishing Co., Inc., New York, N. Y.

Speakers for Labor: Clinton Golden, Committee on Industrial Organization, and Frank Fenton, American Federation of Labor, Washington, D. C.

8:15 p.m.

Power (I) and Fuels (I)

Horizontal Cyclone Burner, by Arthur E. Grunert, superintendent, generating stations, Commonwealth Edison Company, Chicago, Ill., L. Skog, partner, Sargent and Lundy, Chicago, Ill., and Leslie S. Wilcoxson, vice-president, research and development, Babcock & Wilcox Company, New York, N. Y.

Determination of Moisture Content of Coal by Means of Pulverizer Heat Balance, by T. J. Finnegan and H. L. Smith, Buffalo Niagara Electric Corporation, Buffalo, N. Y.

Applied Mechanics (II)

Forced Torsional Vibrations With Damping: An Extension of Holzer's Method, by J. P. Den Hartog, professor of mechanical engineering, and J. P. Li, both of Massachusetts Institute of Technology, Cambridge, Mass.

The Determination of the Natural Frequencies of the Bending Vibrations of Beams, by A. I. Bellin, Harvard University, Cambridge, Mass.

Research Committees on Metal Cutting Data and Bibliography and Cutting Fluids (II)—Production Engineering (II)

Information in final program

Industrial Instruments and Regulators (II)

Performance Data on Butterfly Valves, by S. Dushkes, Askania Regulator Company, Chicago, Ill.

Multiple Element Control Systems, by H. H. Gorrie, Bailey Meter Company, Cleveland, Ohio

Application of Instruments to the Measurement of Rapidly Varying Flows of Gases and Liquids, by H. W. Stoll, Taylor Instrument Companies, Rochester, N. Y.

Rubber and Plastics (II)

Mechanical Precision in Molded Plastic Parts, by S. K. Moxness, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.

Chemical Resistance of Thermosetting Phenolic Laminates, by Wallace Tyrie, chemical department, General Electric Company, Lynn, Mass.

Advances in Plastics During 1946, by Henry M. Richardson, partner, DeBell and Richardson, Springfield, Mass.

Creep, Long-Time Tensile, and Flexural Fatigue Properties of Melamine and Phenolic Plastic Materials, by David Telfair, C. H. Adams, and H. W. Mohrman

TUESDAY, DECEMBER 3

9:30 a.m.

Materials Handling (I)

Handling Materials Through Manufacturing Operations on Conveyer Systems, by W. D. Ligon, works manager, Westinghouse Electric Corporation, Buffalo, N. Y.

Management (II)

Higher Wages and Real Productivity

Speakers: George Terborgh, director of research, Machinery and Allied-Products Institute, Washington, D. C., and C. C. Balderston, dean, Wharton School of Finance, Philadelphia, Pa.

ALEXANDER G. CHRISTIE, HONORARY MEMBER-ELECT, A.S.M.E.

Heat Transfer (I)—American Institute of Chemical Engineers (I)

Symposium: Electrical Radiant Heating in Industry

Application of Radiant Heat for Industrial Purposes, by Paul Goodell, Trumbull Electric Manufacturing Company, Norwood, Ohio

Theory of Radiant Heating With Incandescent Lamps, by F. M. Tiller, assistant professor, chemical engineering, Vanderbilt University, Nashville, Tenn., and Harold J. Garber

Application of Infrared Radiation to the Drying of Explosives, by C. E. Silk, explosive-research department head, Western Cartridge Company, East Alton, Ill., and Howard Clark, physicist, Washington University, St. Louis, Mo.

Power (II) — Fuels (II)

Better Application of Combustion Equipment

A Fuel Engineering Study of Some Recent Boiler Installations, by J. E. Tobey, director, Fairmont Coal Bureau, New York, N. Y.

Designing Coal-Burning Equipment to Eliminate Trouble Spots, by W. H. Rowand, chief staff engineer, Babcock & Wilcox Company, New York, N. Y.

Fuel Economics Affecting Boiler Unit Design, by John Van Brunt, vice-president, engineering, Combustion Engineering Corporation, New York, N. Y.

Better Application of Combustion Equipment for Medium Industrial Plants, by Ollison Craig, engineering manager, Riley Stoker Corporation, Worcester, Mass.

Better Application of Combustion Equipment for Small Industrial Plants, by T. A. Marsh, manager, corporation sales, Iron Fireman Manufacturing Company, Cleveland, Ohio

Wartime Lessons in Coal Burning, by C. E. Miller, principal mechanical engineer, War Department, Office of Chief of Engineers, Washington, D. C.

Pulverized Coal for the Gas Turbine, by Martin Frisch, chief engineer, Foster Wheeler Company, New York, N. Y.

Future Trends in the Application of Coal-Burning Equipment, by F. W. Argue, power engineer, Stone and Webster Engineering Corporation, Boston, Mass.

Applied Mechanics (III)

Control and Prediction of Pulsation Frequency in a Duct System, by W. R. Heath and W. R. Elliott, both of Buffalo Forge Company, Buffalo, N. Y.

A Note on the Damped Vibration Absorber (by title), by John E. Brock, department of applied mathematics, Washington University, St. Louis, Mo.

Citizenship (I)

Auspices of Committee on Engineers' Civic Responsibilities

Discussion of Our Civic Responsibilities—As Individuals, Sections, and Society

12:15 p.m.

Heat Transfer Luncheon

Chairman: W. H. McAdams, professor, Massachusetts Institute of Technology, Cambridge, Mass.

Cushing, New York

CITY HALL AND THE MUNICIPAL BUILDING SKYSCRAPER, NEW YORK, N. Y.

Welcome: T. B. Drew, Columbia University, New York, N. Y.

Speaker: L. M. K. Boelter, dean, college of engineering, University of California, Los Angeles, Calif.

Subject: Professional and Scientific Significance of Some Advances in Heat Transfer

Management Luncheon

Speaker: Paul G. Hoffman, The Studebaker Corporation, South Bend, Ind., 1946 Gantt Medalist

Subject: The Outlook for Freedom

2:30 p.m.

Power (III)—Boiler Feedwater Studies (I)

Corrosion-Erosion of Boiler Feed Pumps and Regulating Valves, by H. W. Wagner, J. M. Decker, and J. C. Marsh, The Detroit Edison Company, Detroit, Mich.

Investigation of Acid Attack on Boilers and the Effect of Repeated Acid Cleaning on the Metal, by H. C. Farmer, chief chemist, Philadelphia Electric Company, Philadelphia, Pa.

Materials Handling (II)

Three Systems for Handling and Storing Metal Chips, by Sidney Reibel, materials-handling consultant, Albert Kahn Associated Architects & Engineers, Inc., Detroit, Mich.

Materials Handling in the Cleaning of Foundry Castings, by T. J. Potter, executive vice-president, Pangborn Corporation, Hagerstown, Md.

Production Engineering (III)

Surface Roughness, Waviness, and Lay and Its Application in Actual Practice, by R. Shell, General Electric Company, Hartford, Conn.

The Development of Jacketed Drier Rolls, by William H. Funk, development engineer, Lukens Steels, Coatesville, Pa.

Management (III)

Pricing Policies and Social Trends

Speaker: Harold G. Moulton, president, The Brookings Institution, Washington, D. C. A panel discussion will follow. Speakers will be: Dexter Keezer, director, department of economics, McGraw-Hill Publishing Company, New York, N. Y.; Joel Dean, professor, Columbia University, New York, N. Y.; Bradford B. Smith, U. S. Steel Corporation, New York, N. Y.; Lew Hahn, general manager, National Retail Dry Goods Association, New York, N. Y.

2:30 p.m.

Education and Training (I)

Responsibility of Engineering Colleges in Development Ingenuity .

Speakers: Elliott Dunlap Smith, provost, Carnegie Institute of Technology, Pittsburgh, Pa., and George A. Stetson, editor, A.S.M.E., New York, N. Y.

Wood Industries (I)

Temperature Distribution in White Oak Laminated Timbers Heated in a High-Frequency Electric Field, by M. E. Dunlap, engineer, and E. R. Bell, physicist, Forest Products Laboratory, Forest Service, U. S. Department of Agriculture, Madison, Wis.

Have You Returned E. J. C. Questionnaire?

A.S.M.E. members are again urged to return the questionnaire in the survey on the economic status of the engineer if they have not already done so. This survey is being sponsored by the Engineers Joint Council in co-operation with the Bureau of Labor Statistics of the U. S. Department of Labor for the benefit of the engineering profession.

The physical conduct of the survey is being carried out by the Bureau of Labor Statistics only because it is equipped to handle this type of precoded questionnaire.

The survey on the economic status of the engineer is one of several projects sponsored by the Engineers Joint Council as a service to the engineering profession. The E.J.C. is composed of the following member societies: the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Chemical Engineers. The National Society of Professional Engineers is also participating in the survey.

Full account of the questionnaire was published on page 845 of the Sept., 1946, issue of MECHANICAL ENGINEERING.

Remember, Nov. 15 is the dead line for returning questionnaires.

Wood-to-Metal Adhesives, by Thomas D. Perry, development engineer, Resinous Products and Chemical Company, Philadelphia, Pa.

Control of Marine Borers in Plywood, by Albert P. Richards and W. F. Clapp, W. F. Clapp Laboratories, Duxbury, Mass.

The Manufacture of Wood-Cased Pencils, by Charles R. Nichols, Jr., Joseph Dixon Crucible Company, Jersey City, N. J.

Hydraulic

Model Tests of Granby Pumps, by B. L. Vander Boegh, Newport News Shipbuilding and Dry Dock Company, Newport News, Va.

Hydro Power in Wartime Germany, by A. Hoefle, Toledo Edison Company, Toledo, Ohio

3:00 p.m.

Heat Transfer (II)—American Institute of Chemical Engineers (II)

Symposium: Gas-Fired Radiant Heating in Industry

Radiant Gas Heat at Elevated Temperatures, by James Kniveton, Selas Corporation of America

The Role of Convection in Medium Temperature Processing, With Special Reference to Its Influence on the Design of Infrared Ovens, by J. B. Carne, South Metropolitan Gas Company, London, England. (To be presented by C. G. Segeler of the American Gas Association.)

6:00 p.m.

Wood Industries Dinner

Hydraulic Dinner

Applied Mechanics Dinner

Speaker: Everett S. Lee, engineer, general engineering and consulting laboratory, General Electric Co., Schenectady, N. Y.
Subject: Recent Impressions of Europe

8:15 p.m.

Heat Transfer (III)—Process Industries (I)

Correction for Heat-Conduction Through Longitudinal Baffle of Heat-Exchangers, by A. M. Whistler, C. F. Braun and Company, Alhambra, Calif.

Shell-Side Coefficients of Heat Transfer in a Baffled Heat Exchanger, by H. S. Gardner, associate professor of chemical engineering, University of Rochester, Rochester, N. Y., and Irving Siller, The Pfaudler Company, Rochester, N. Y.

Materials Handling (III)

Pallet Handling Systems in Warehousing and Transportation, by David Pursley, materials handling manager, Lawrence Warehouse Company, San Francisco, Calif.

Management (IV)

Case Histories of Engineering Distribution
Speakers to be announced

Research Committees on Metal Cutting Data and Bibliography and Cutting Fluids (III)—Production Engineering (IV)

Information in final program

Official Notice

A.S.M.E. Business Meeting

THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday afternoon, December 2, 1946, at 4:00 p.m. at the Pennsylvania Hotel, New York, N. Y., as a part of the Annual Meeting of the Society.

Aviation (II)—Industrial Instruments and Regulators (III)

Instrumentation for Helicopters, by C. F. Savage and R. G. Jewell, design engineers, aeronautical instrument engineering division, General Electric Company, West Lynn, Mass.

Instrumentation for Jet-Propelled Planes, by C. A. Edman, engineer, aeronautical instrument engineering division, General Electric Company, West Lynn, Mass.

WEDNESDAY, DECEMBER 4

9:30 a.m.

Oil and Gas Power (I)—Power (IV)

Gas Turbines

Part-Load Characteristics of Marine Gas Turbine Plants, by W. M. Rohsenow, assistant professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass., and J. P. Hunsaker, consulting engineer, Jackson and Moreland, Boston, Mass.

Some Effects of Pressure Loss on Open-Cycle Gas Turbines, by J. I. Yellott, director of research, Locomotive Development Committee, Baltimore, Md., and Eric F. Lype, instructor and section supervisor, Illinois Institute of Technology and Institute of Gas Technology, Chicago, Ill.

Management (V)

Industrial Conservation: How a nation-wide Industrial Conservation Program will alleviate the present short supply of strategic materials
Speakers to be announced

Heat Transfer (IV)—Wood Industries (II)

Further Remarks on the Analogy Between Heat and Momentum Transfer, by R. C. Martinelli, general engineering and consulting laboratory, General Electric Company, Schenectady, N. Y.

The Cofficients of Thermal Expansion of Wood and Wood Products, by R. C. Weatherwax and A. J. Stamm, chemists, Forest Products Laboratory, University of Wisconsin, Madison, Wis.

Fuels (III)

The National Fuel Reserves and Their Relation to the Future Supply of Liquid Fuel, by A. C. Fieldner, Bureau of Mines, Washington, D. C.

Factors Rarely Considered in Smoke Abatement, by H. F. Hebley, Pittsburgh Coal Company, Pittsburgh, Pa.

Process Industries (II)

Applications of Dielectric Heating, by E. G. Ports, Federal Telephone and Radio Corporation, Newark, N. J.

Dielectric Drying of Ceramic Insulation. (Speaker to be announced.) Motion pictures will be shown.

Research Committees on Metal Cutting Data and Bibliography and Cutting Fluids (IV)—Production Engineering (V)

Information in final program

10:00 a.m.

Railroad Division Executive and General Committee Meeting

12:15 p.m.

Fuels Luncheon

Speaker: Philip Swain, editor, *Power*, McGraw-Hill Publishing Co., Inc., New York, N. Y.
Subject: What Really Happened at Bikini—An Engineer's Interpretation

12:30 p.m.

Student Luncheon

Toastmaster: Risden P. Reece, chairman, Committee on Relations With Colleges
Addresses: D. Robert Yarnall, president, A.S.M.E.
Eugene W. O'Brien, President-Elect, A.S.M.E.
Presentations: Undergraduate Student Award, to Paul A. Thompson, Illinois Institute of Technology, Aurora, Ill., and the Charles T. Main Award, to Victor S. Rykwalder, University of Detroit, mechanical engineer, Wyandotte Chemical Corporation, Wyandotte, Mich.

2:00 p.m.

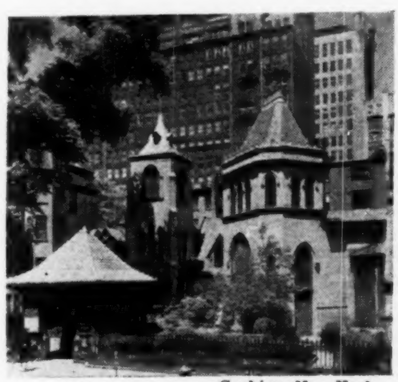
Railroad (I)

Symposium: Diesel Locomotive Design for Reduced Maintenance

Keynote speaker and presiding officer: J. P. Morris, general assistant, Atchison, Topeka and Santa Fe Railroad

Prepared discussions:

Diesel Prime Movers, by H. H. Urbach, mechanical assistant to vice-president, Chicago, Burlington and Quincy Railroad, Chicago, Ill.



Cushing, New York

"THE LITTLE CHURCH AROUND THE CORNER" ON 29TH STREET, JUST EAST OF FIFTH AVENUE, NEW YORK, N. Y.

Electrical Equipment, by W. C. Marshall, assistant supervisor of motive power, Chicago, Milwaukee, St. Paul and Pacific Railroad, Chicago, Ill.

Chassis and Running Gear, by G. F. Wiles, supervisor, Diesel-locomotive operation, Baltimore and Ohio Railroad

Accessories, by F. Thomas, assistant to general superintendent of motive power, New York, N. Y.

2:30 p.m.

Oil and Gas Power (II)—Power (V)

Gas Turbines

The Value of Wet Compression in Gas-Turbine Cycles, by R. V. Kleinschmidt, Stoneham, Mass.

Gas Turbines With Water Injection, by C. A. Norman, professor, Ohio State University, Columbus, Ohio, and R. H. Zimmerman

Heat Transfer (V)

Heat Requirements for Instruments and Airfoils During Ice Storms, by Vincent J. Schaefer, research laboratory, General Electric Company, Schenectady, N. Y.

Instrumentation for Flight-Testing of Thermal Anti-Icing Systems, by W. C. Droege, Aero Ice Research Laboratory, Northwest Airlines, Minneapolis, Minn.

Determination of the Thermal Correction for a Single Shielded Thermocouple, by W. M. Rohsenow, professor, Massachusetts Institute of Technology, Cambridge, Mass., and J. P. Hunsaker, consulting engineer, Jackson and Moreland, Boston, Mass.

Electrically-Heated Glove for Determining Local Values of Heat-Transfer Coefficients, by J. K. Goss, Aero Ice Research Laboratory, Northwest Airlines, Minneapolis, Minn.

2:30 p.m.

Education and Training (II)

Engineers' Need for Commercial Imagination

Speakers: Carroll L. Wilson, Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C., and S. A. Holme, General Electric Company

Process Industries (III)

Ceramic Insulator Drying by Dielectric Heat· (Speaker to be announced.)

Tetraethyl Silicate as a Heat-Transfer Fluid, by John B. Pierce, Pierce Foundation, Raritan, N. J.

Round-table discussion will follow papers.

6:00 p.m.

Banquet

Information in final program

THURSDAY, DECEMBER 5

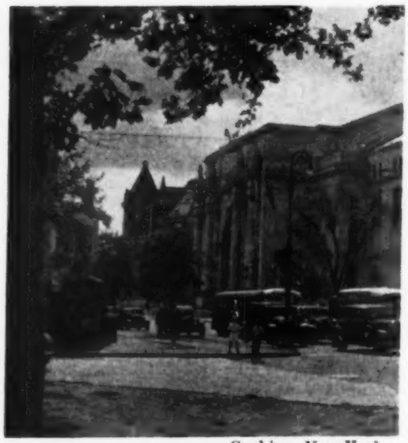
9:30 a.m.

Oil and Gas Power (III)—Power (VI)

Gas Turbine

Recent Gas Turbine Developments, by Dr. Adolphe Meyer, Brown, Boveri Company, Baden, Switzerland

A 2000-Hp Gas-Turbine Generator Set, by T. J. Butz, gas-turbine engineer, Westinghouse Electric Corporation, S. Philadelphia, Pa.



Cushing, New York

THE THEODORE ROOSEVELT WING OF THE MUSEUM OF NATURAL HISTORY AT 81ST STREET ON WEST SIDE OF CENTRAL PARK, NEW YORK, N. Y.

Railroad (II)

Annual Report on Progress in Railway Mechanical Engineering and Symposium on Weight Savings in Passenger-Car Specialties

Keynote speaker and presiding officer, P. W. Kiefer, chief engineer, motive power and rolling stock, New York Central System, New York, N. Y.

Prepared discussions: Eleven 10-minute papers from supply companies in the railroad field.

Heat Transfer (VI)

Control of Structural Temperatures in Jet-Propelled Aircraft, by G. F. Anisman and M. W. Blackstone, North American Aviation, Municipal Airport, Los Angeles, Calif.

Review of Some German Developments in Airplane Anti-Icing, by Myron Tribus, research staff member, college of engineering, University of California, Los Angeles, Calif.

Liquid Water Content and Droplet Size in Atmospheric Clouds, by G. W. Brock, West Lafayette, Ind.

Boiler Feedwater Studies (II)

Information in final program

Graphitization (I)

Findings of the Co-operative Program of the Valve Manufacturers on Graphitization in Casting, by J. J. Kanter, materials research engineer, Crane Company, Chicago, Ill.

A Report on Graphitization Studies in Philadelphia Electric Company's High Temperature Welded Piping, by A. E. White, director, department of engineering research, University of Michigan, Ann Arbor, Mich., and E. L. Hopping, mechanical engineer, Philadelphia Electric Company, Philadelphia, Pa.

Fuels (IV)

Progress Report on Pressurized Combustion of Pulverized Coal: Coal Preparation; Fly-Ash Removal; and Introduction to Com bustion, by. J. I. Yellott, director of research, Locomotive Development Committee, Baltimore, Md.

Furnace Temperature Control of Large Steam-Generating Units, by Otto de Lorenzi, director of education, Combustion Engineering Company, Inc., New York, N. Y.

Applied Mechanics (IV)

Maximum Performance of Helical Springs, by Erle I. Shobert, II, Stackpole Carbon Company, St. Marys, Pa.

Theory of Curved Beams, by Gilbert C. Best, San Diego, Calif.

Bending of Clamped Plates, by W. B. Stiles, professor, department of theoretical and applied science, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa

12:15 p.m.

Railroad Luncheon

Speaker: G. Metzman, president, New York Central System, New York, N. Y.

2:00 p.m.

Railroad (III)

Continuation of Passenger Car Symposium

Oil and Gas Power (IV)—Aviation (III)—American Rocket Society (I)

Aircraft Turbo-Jet and Prop-Jet Starter Systems, by Captain A. G. Bardwell, Jr., electrical branch, equipment laboratory, engineering division, Air Materiel Command, Wright Field, Dayton, Ohio

The Liquid Propellant Rocket Motor—Past, Present, and Future, by J. H. Wyld, Reaction Motors, Dover, N. J.

Cold Weather Tests on Jet-Propulsion Engines in Canada, by R. L. Whitelaw, acting chief experimental engineer, A. V. Roe, Canada, Limited, Malton, Ont., Can.

2:30 p.m.

Education and Training (III)

Subject: Ingenuity in Production Engineering

Speakers: A. R. MacAlmon, manager, job and apprentice training, department of education, International Business Machines Corporation, Endicott, N. Y., and B. D. Kunkle, vice-president, General Motors Corporation, Detroit, Mich.

Heat Transfer (VII)

High-Altitude Flight Cooling Investigation of an Air-Cooled Engine, by E. J. Manganiello and M. F. Valerino, N.A.C.A. Laboratory, Cleveland Airport, Ohio

N.A.C.A. Correlation of Cylinder Temperatures for Liquid-Cooled Engines, by Benjamin Pinkel, E. J. Manganiello, and E. Bernardo, N.A.C.A. Laboratory, Cleveland Airport, Ohio

Applied Mechanics (V)—Metals Engineering (I)—Plastic Flow of Metals (I)

The Flow of Metals Through Tools of Circular Contour, by George Sachs, professor, Case School of Applied Science, Cleveland, Ohio, and L. J. Klinger, department of metallurgical engineering, Case School of Applied Science, Cleveland, Ohio

Plastic Deformation in a Nonhomogeneous Field of Stress, by R. D. Mindlin, associate professor, civil engineering, Columbia University, New York, N. Y.

Fuels (V)

Some Practical Applications of Flue-Gas Recirculation, by E. Durham and W. H. Rowand, Babcock and Wilcox Company, New York, N. Y.
Clogging of Coal in Bunkers, by R. F. Legget, University of Toronto, Toronto, Ont., Canada

Research Committee on Fluid Meters

Measurement of Flow at Supersonic Velocities, by Neil P. Bailey, head, mechanical-engineering department, Rensselaer Polytechnic Institute, Troy, N. Y.
Analysis of Viscosity Data From Norman Flowmeter Tests, by L. K. Spink, engineer in charge of flow measurement, The Foxboro Company, Neponsett, Mass., and E. E. Ambrosius, professor, mechanical engineering, The Pennsylvania State College, State College, Pa.
Orifice Discharge Coefficient for Liquids in Viscous Flow Range, by G. S. Peterson, section engineer, Gulf Research and Development Company, Pittsburgh, Pa.

Power (VII)

Notes on Submarine Design, by Commodore A. I. McKee, Philadelphia Naval Shipyard, Naval Base Station, Philadelphia, Pa.
Production and Use of Hydrogen Peroxide by the Germans During World War II, by Captain Logan McKee, chief of design branch, Bureau of Ships, U. S. Navy, Washington, D. C.
Development of Steam Turbines for Main Propulsion of High-Powered Combatant Ships, by Glenn B. Warren, design engineer, turbine-generator division, General Electric Company, Schenectady, N. Y.

8:15 p.m.

Heat Transfer (VIII)

Panel Discussion: Problems of Aircraft-Engine and Accessory Cooling

Topics to be considered in this session include: Engines, Liquid-Cooled; Engines, Air-Cooled; Oil Coolers; Radiators; and Intercoolers.

Graphitization (II)

Continuation of the Joint E.E.I.-A.E.I.C. Investigation on Graphitization of Piping, by S. L. Hoyt, technical adviser; R. D. Williams, welding engineer; and A. M. Hall, research engineer, Battelle Memorial Institute, Columbus, Ohio
Influence of Postweld Heat-Treatment on Graphitization, by I. A. Rohrig, research department, and Arthur McCutchan, engineer, The Detroit Edison Company, Detroit, Mich.

Applied Mechanics (VI)—Metals Engineering (II)—Plastic Flow of Metals (II)

Some Basic Principles of Tube Drawing, by R. G. Sturm, research professor, Purdue University, West Lafayette, Ind.
Method of Manufacture of Aluminum Tubing. (Speaker to be announced.)
Experimentation on Tube Drawing With a Moving Mandrel, by George Sachs, professor, and George B. Espey, field engineer in metallurgical engineering, Case School of Applied Science, Cleveland, Ohio

FRIDAY, DECEMBER 6

9:30 a.m.

American Rocket Society (II)—Oil and Gas Power (V)

Long-Range Rocket Bombs, by Major H. L. Karsch, ordnance department, chief proof officer, White Sands Proving Gounds. (With films.)
Rocket Power Plants for Aircraft, by Harry N. Burdett, Reaction Motors, Inc. (illustrated)
Testing Naval Pilotless Aircraft, by Commander Grayson Merrill, U.S.N., technical director, naval pilotless aircraft unit, Mojave, Calif. (With accompanying films.)
Commercial Applications of Rocket Power, by a representative from Aerojet Engineering Corporation. (Possibly accompanied by films.)

Machine Design (I)

Design Features of Large Horizontal Surface-Broaching Machines, by George Squibb, Cincinnati Milling Machine Company, Cincinnati, Ohio
Stress and Strength Requirements in the Design of Machine Parts, by Charles Lipson, Chrysler Corporation, Detroit, Mich.
The Use of Electric Gaging Equipment in Machine Design, by P. E. Nokes and E. G. Carr, United Shoe Machinery Corporation, Beverly, Mass.

Lubrication

Measurement of the Viscosity and Shear Elasticities of Liquids by Means of a Torsional Vibrating Crystal, by W. P. Mason, Bell Telephone Laboratories, Murray Hill, N. J.

Applied Mechanics (VII)—Metals Engineering (III)—Plastic Flow of Metals (III)

The Influence of Size on the Brittle Strength of Steel, (by title), by N. N. Davidenkov
The Initiation and Propagation of the Plastic Zone in a Tension Bar of Mild Steel Under Eccentric Loading, by Julius Miklowitz, Harvard University, Cambridge, Mass.
The Initiation and Propagation of the Plastic Zone in a Tension Bar of Mild Steel as Influenced by the Speed of Stretching and Rigidity of Testing Machine, by Julius Miklowitz, Harvard University, Cambridge, Mass.

Strength of Vessels

Unfired Cylindrical Vessels Subjected to External Pressure, by F. V. Hartman, mechanical engineer, Aluminum Ore Company, E. St. Louis, Mo.
Master Charts for the Design of Vessels Under External Pressure, by D. F. Windenburg, chief physicist, David Taylor Model Basin, U. S. Navy Department, Washington, D. C.
Calculating the Collapsing Strength of Vessels Subject to External Pressure, by R. G. Sturm, professor of engineering mechanics and research professor of materials, school of civil engineering and engineering mechanics, and H. L. O'Brien, Purdue University, Lafayette, Ind.

12:15 p.m.

Textile Luncheon

Aviation—Oil and Gas Power—American Rocket Society Luncheon

Toastmaster: Eugene O'Brien, President-Elect A.S.M.E.
Introduction of Speaker: R. G. Standerwyck, aircraft-gas-turbine division, General Electric Company, Lynn, Mass.
Speaker: Air Commodore Frank Whittle, R. A. F. Subject: Development of Turbo-Jet Engines

2:30 p.m.

Aviation (IV)—American Rocket Society (III)—Oil and Gas Power (VI)

Problems of Supersonic Aircraft Flight, by Lieut. Col. Carl E. Reichert, Aircraft Laboratory, Air Materiél Command, A.A.F.—Films.
Critical Analysis of Dr. R. H. Goddard's Rocket Research, by Alfred Africano, Curtiss-Wright Corporation. (With films and slides.)
Ramjet and Pulsejet Propulsion by a representative from the Aeronautical Research Laboratory, N.A.C.A.
Design Trends in Turbo-Jet Engines by N.A.C.A. Engine Research Laboratory representative.
Chairman of Morning Session—Lovell Lawrence, president of American Rocket Society

Machine Design (II)

Kinematics of Disk Cam and Flat Follower, by Allan H. Candee, Gleason Works, Rochester, N. Y.
A Theoretical Derivation of Ball-Bearing Ratings, by Thomas Barish, Washington, D. C.

Textiles

Information in final program

Metals Engineering (IV)

Precision Casting, by J. D. Corfield, vice-president, Michigan Steel Casting Company, Detroit, Mich.
Powder Metallurgy, by L. S. Foster, Watertown Arsenal, Watertown, N. Y.
Shot Peening, by J. O. Almen, research laboratory division, General Motors Corporation, Detroit, Mich.

Applied Mechanics (VIII)

Gas Turbine Seminar Session

Stress Consideration, by W. B. Goddard, N. C. Price, C. C. Davenport, R. G. Allen

Preprints of 1946 Annual Meeting Papers

A list of 1946 Annual Meeting papers available for distribution in preprint form at time of going to press is published on page 998 of this issue.

Gas Turbine Materials

Precipitation-Hardened Alloys for Gas-Turbine Service, by Howard Scott and R. B. Gordon, Westinghouse Electric Corporation, South Philadelphia, Pa.

Materials for Power Gas Turbines, by C. T. Evans, Jr., The Elliott Company, Jeannette, Pa.

Nickel-Chromium Alloys for Gas-Turbine Service, by C. A. Crawford, development and research department, International Nickel Company, New York, N. Y.

Safety

Industrial-Accident Prevention

Chairman: Dr. Herbert J. Stack, director, New York University

Speakers: Methods of Control for Engineers in Accident Prevention, by H. W. Heinrich

The Educator's Opportunities in the Field of Accident Prevention, by Walter Cutter, New York University, New York, N. Y.

Engineering-College Training for Management Accident Control, by A. W. Luce, professor, mechanical-engineering department, Pratt Institute, Brooklyn, N. Y.

The Student Engineer Prepared for Safety Engineering, by John Grimaldi, research engineer, National Conservation Bureau, New York, N. Y.

6:00 p.m.

Joint A.S.M.E.—American Rocket Society Dinner

Rocket Projectile Development (with films and slides), by C. N. Hickman, Bell Telephone Laboratories, wartime chief, Section H, Division 3, National Defense Research Committee, Washington, D. C.

P. G. Hoffman Receives Gantt Medal

THE Henry Laurence Gantt Memorial Gold Medal was presented to Paul G. Hoffman, president, The Studebaker Corporation, South Bend, Ind., at a dinner meeting of the American Management Association, held at the Statler Hotel, Boston, Mass., Oct. 8, 1946.

The Gantt Medal, awarded jointly by The American Society of Mechanical Engineers and the American Management Association, was conferred upon Mr. Hoffman for "providing an inspiring, practical example of successful management-labor relations in a free society preserving the best traditions of the American heritage of individual dignity, democracy, and personal responsibility; and for able leadership in developing private and public management policies to promote the general welfare by fostering a stable national economy."

The presentation was made by John A. Willard, member A.S.M.E. chairman, Gantt Medal Board of Award. Mr. Hoffman, after accepting the Medal, addressed the meeting, using for his subject, "Wanted: Pioneers in Human Relations."

The Gantt Medal was established in 1929 to memorialize the achievements and service to the community by Henry Lawrence Gantt, management engineer and industrial leader.

A.S.M.E. Sponsors International Understanding

IN marked contrast to some of the wide publicity given to the suspicion and conflicting aims of the peacemakers, The American Society of Mechanical Engineers through the Committee on International Relations of the Engineers Joint Council, has achieved quiet success in its program of co-operation and mutual aid among engineers and engineering societies of the world.

During the last year the Committee has sponsored a project to furnish technical books and periodicals to war-devastated libraries; it has worked to win recognition for engineers on the American Commission for Educational, Scientific, and Cultural Co-operation to UNESCO; it has organized American participation in two international technical congresses; it has played host to visiting foreign engineers and has assisted them in arranging itineraries and in obtaining letters of introduction to American engineers; it has carried on communications with foreign engineering bodies in order to establish mutual benefits to the engineering profession on a world-wide basis.

The Committee on International Relations was originally organized by the A.S.M.E. in June, 1945, but when its program won the enthusiasm of other engineering societies, the Committee was reorganized under the E.J.C. to broaden its base and enhance its effectiveness.

E.J.C. Book Project

The Committee accepted and forwarded to war-devastated libraries 3927 engineering books, 8402 periodicals and 5267 copies of proceedings, transactions, and indexes of engineering societies' publications since inauguration of the book project. In addition, more than 4000 books and pamphlets from the late John R. Freeman library were shipped to the National Resources Commission Library in Nanking, China.

The Committee helped to organize American participation in the International Technical Congress at which 20 papers by American engineers were read, and in the Applied Mechanics Congress to which 35 American papers were contributed. Both congresses were held in Paris during September, 1946.

When the Hydroelectric Power Commission of Egypt visited the United States recently to place orders for equipment for the Aswan Dam Project in Egypt, the E.J.C. Committee assisted the visiting engineers by arranging itineraries, selecting plants and projects to visit, and by providing them with introductions to American engineers.

Committee

Members of the E.J.C. Committee on International Relations are:

Malcolm Pirnie, chairman, member A.S.C.E.; R. M. Gates, vice-chairman, fellow A.S.M.E.; Joseph Pope, member A.S.M.E.; Earnest Pragst, member A.S.M.E.; F. B. Turck, member A.S.M.E.; W. N. Carey, secretary, A.S.C.E.; A. B. Parsons, secretary, A.I.M.E.; C. E. Davies, secretary, A.S.M.E.; H. H. Henline, secretary, A.I.E.E.; S. L. Tyler, secretary, A.I.Ch.E.

Advisory members are: W. L. Batt, fellow and honorary member A.S.M.E.; M. L. Cooke, fellow A.S.M.E., P. R. Faymonville, member A.S.M.E; E. A. Pratt, member A.S.C.E.; S. S. Steinberg, member A.S.C.E., Wallace Clark, fellow A.S.M.E.; Howard Coonley, associate member A.S.M.E.; J. C. Parker, fellow A.S.M.E.; H. S. Rogers, member A.S.C.E.; and Harry Warfel.

The Engineers Joint Council is composed of the following members: American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, and the American Institute of Chemical Engineers.

I.S.A. Installs 1946–1947 Officers

THE Instrument Society of America installed its officers for 1946–1947 at a meeting held in the William Pitt Hotel, Pittsburgh, Pa., Sept 18, 1946. The new officers are: C. O. Fairchild, president; Carl F. Kayan, member A.S.M.E., first vice-president; H. Barnum, vice-president; J. B. McMahon, member A.S.M.E., vice-president; Ralph Munch, vice-president; Hugh Ferguson, treasurer; and Richard Rimbach, member A.S.M.E., executive secretary.

U. S. Engineers Contribute to Australian Meeting

A symposium on the Failure of Metals by Fatigue sponsored by the faculty of engineering of the University of Melbourne, Melbourne, Australia, will be held at the University during a week between Nov. 18 and Dec. 13, 1946.

Among the twenty-eight papers to be presented, there will be one by the staff of the Battelle Memorial Institute, Columbus, Ohio, and one by George Sachs, member A.S.M.E., professor of physical metallurgy, Case School of Applied Science, Cleveland, Ohio.

Reprint Available

BECAUSE of favorable comment and numerous requests for copies which have exhausted the original printing, the article "Creative Thinking and How to Develop It," by William H. Easton, published in the August, 1946, issue of MECHANICAL ENGINEERING, has been reprinted in the form of a pamphlet $4^1/_2 \times 7$ in. and is now available for $0.25 a copy.

Requests should be addressed to The American Society of Mechanical Engineers, Publication Sales, 29 West 39th Street, New York 18, N. Y.

President's Page

E.J.C. Program for 1946–1947

On this page in September I told you about E.J.C., the Engineers Joint Council, that agency of the national engineering societies which is composed of the presidents in office, the junior past-presidents, and the secretaries of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Chemical Engineers.

E.J.C. has a remarkable and unique opportunity for highly constructive leadership, if we will only give to it the study and effort it deserves.

Admittedly, E.J.C. is an "interim" agency. But *every* agency, viewed with sufficient perspective, is an *interim* body. Nothing in life is final. Almost everything is a prelude to that which is to follow.

As the character and functions of government, management, labor, technical and international organizations evolve, so must our engineering societies also evolve. We must adapt ourselves to these changing interrelationships, or perish.

Never before has there been greater need for integration of engineers within each society, for co-ordination of the societies with each other at home and abroad, for joint action of our societies with national and international government units.

We must work with *all* constructive efforts of management, labor, the various technical groups, and social scientists—to make secure and to improve our economic, political, and social life—to *really* win "The Four Freedoms" for all peoples.

Our welfare in every professional and human relationship is at stake. We can not isolate ourselves politically, economically, or professionally. We must help E.J.C. guide and speed the evolution of a truly representative and efficient organization of the engineering profession, for the public is expecting much of the engineers in the years ahead.

Vannevar Bush reminded us recently, you remember, "that the path of professional attainment" leads where "the watchword is that old, old theme, which has never lost its flavor, and which may yet save a sorry world: Simple ministration to the people."

E.J.C. policies should reflect the best thought of all the members of the five participating groups. We are counting on your prompt and full co-operation and interest in E.J.C. activities in the critical years ahead!

D. Robert Yarnall, *President, A.S.M.E.*

New England's Industrial Power Highlights First A.S.M.E. Fall Meeting Since 1943

Boston, Mass., Scene of Activities, Sept. 30–Oct. 3

EMPHASIS was placed upon New England's industrial potential and the ability of its engineers at the 1946 Fall Meeting of The American Society of Mechanical Engineers, held at the Hotel Statler, Boston, Mass., Sept. 30–Oct. 3, 1946. Adequately to stress the manufacturing ability of New England one has but to look back upon the part it played during the recent world conflict. Despite having only 2.2 per cent of the nation's land area and only 6.4 per cent of the country's population, New England turned out 9 per cent of the total war supplies, according to Admiral M. L. Deyo, speaker at one of the luncheons.

As for postwar activities, the addresses and papers at the luncheons, dinners, and technical sessions indicated that New England is looking forward to remaining one of the country's foremost industrial centers.

More than 1200 engineers, their wives, and guests registered for the meeting. They participated in an extensive program made up of 21 technical sessions, which covered such subjects as power, aviation, textiles, management, education and training, hydraulics, wood industries, metals engineering, design, heat transfer, fuels, instruments, and metal cutting; nine inspection trips, both historical and technical; and nine luncheons and dinners, including the banquet.

Luncheons and Dinners

Nearly 1300 persons attended the luncheons, dinners, and the banquet held during the four-day meeting.

At the opening luncheon on Monday, Sept. 30, Governor Maurice J. Tobin of Massachusetts extended greetings from the Commonwealth. Congratulating the A.S.M.E. for the job it did during the war he pointed out that it took engineers to develop production of what scientists devised.

D. Robert Yarnall, president, A.S.M.E., president, Yarnall-Waring Company, Philadelphia, Pa., extended greetings from the Society. He said that the nation looks to the engineer in times of national crisis such as the present, and he assured the members and guests that "the nation's trust in him will not be in vain." He also declared, "Our engineering sights should be inspected more often. The engineer in the United States is a vital factor in the life of his nation and we are aware that our countrymen are expecting much of engineers these days."

F. S. Blackall, jr., member A.S.M.E., director-at-large-elect A.S.M.E., president, New England Council, president and treasurer, The Taft-Pierce Mfg. Co., Woonsocket, R. I., delivered the luncheon address, in which he made a plea for higher standards in the engineering profession through more stringent requirements for college engineering degrees. He warned that engineering societies must "guard their portals jealously against gate crashing by self-styled engineers who couldn't even read a slide rule." (Mr. Blackall's entire address will be found elsewhere in this issue.)

H. M. King, member A.S.M.E., assistant engineer, steam-turbine-engineering division, General Electric Co., Lynn, Mass., chairman of the Fall Meeting Committee, served as toastmaster.

Local Engineering Societies

At the dinner Monday night Sept. 30, Albert Haertlein, professor, Harvard Engineering School, and president, Engineering Societies of New England, Inc., was the principal speaker. He spoke on the co-operation between local engineering societies in the Boston area and the Engineering Societies of New England.

Toastmaster at the dinner was C. W. MacGregor, member A.S.M.E., professor of applied mechanics, Massachusetts Institute of Technology, Cambridge, Mass.

Wood Industries Luncheon

An interesting session was provided for members who attended the Wood Industries luncheon on Tuesday, Oct. 1. A. B. Atwood, Atwood and McManes, Chelsea, Mass., showed moving pictures depicting the manufacture of wooden boxes and lumbering operations.

Textile Luncheon

Nearly 200 attended the Textile luncheon, also held Tuesday, Oct. 1, at which the Hon. Clarence A. Barnes, Attorney General of Massachusetts, served as toastmaster. Austin S. Kibbee, Commander, U.S.N., retired, technical adviser, Manawul Manufacturing Company, Boston, Mass., gave an interesting talk on Ramie, commercially known as China grass, a fiber plant used for textiles.

He described how experiments had increased the height of perennial plants from three to six feet in China and to eight feet in Florida. Ramie grass yields three to four crops per year and has no insect or fungus pests and requires little cultivation or care until harvest.

A solution had to be found to the problem of economically degumming Ramie or China grass. In 1934 a new process appeared. The use of chemistry and simple technique cut down the degumming time to less than two hours and required no special machinery either in degumming or spinning processes used with short staple.

The fiber of Ramie suitable for textile purposes lies directly beneath the outer bark, in thin layers called "bundles," held together firmly by cementitious matter. China grass "strippings," commercially called "ribbons," are composed of numerous bundles of the fiber. In the Orient these ribbons are stripped from the Ramie stalk by hand, which is the crudest method of decorticating. For the purpose of short-staple processing of Ramie, a machine that surpasses anything yet come across has been adopted. It is sturdy, dependable, and economical, and it is believed

Courtesy Christian Science Monitor.

AT THE MEETING OF THE EXECUTIVE COMMITTEE OF THE COUNCIL

(*Left to right:* A. C. Chick, D. Robert Yarnall, E. W. O'Brien, and John E. Lovely.)

HONORABLE MAURICE J. TOBIN EXTENDS GREETINGS FROM THE COMMONWEALTH AT MONDAY'S LUNCHEON

that it can decorticate Ramie at a fraction of the price of hand decortication by the Chinese.

Working with textile manufacturers before the war, the Manawul producers turned out economically many yarns and fabrics, including blends of Ramie with cotton, wool, or "synthetics." These included corduroy, linen-like table "sets," white goods, as prints, dress goods, suiting, overcoatings, both woven and knitted, bathroom mats, carpet, automobile upholstery, knitting yarns and products, hydraulic packing, fire-hose yarn, braided cord, cordage, and sundry textiles.

Students' Night

At the dinner held on Tuesday evening Oct. 1, Eugene W. O'Brien, fellow A.S.M.E., president-elect A.S.M.E., vice-president and director W.R.C. Smith Publishing Company, Atlanta, Ga., told a large audience of student members that it is up to the "engineers of tomorrow"—the students now being trained as engineers and technical executives—to see that the world makes full use in peacetime of the many technological and sociological gains hard-won under wartime stress.

He urged the students to add to their technical know-how an understanding of people, a development of traits of friendliness and leadership, courage and vision, and that they regard their profession as opening up a career of service in which their knowledge will be used for the common good. W. C. White, Director of Day Colleges, Northeastern University, Boston, Mass., acted as toastmaster.

Also held on Tuesday evening, Oct. 1, was a Textile dinner at which N. M. Mitchell, member A.S.M.E., president, manager, Barnes Textile Association, Boston, Mass., gave an interesting talk on textile college undergraduate education.

New England Industry

The significant contribution of New England's industry and workers in winning the past war was described at a luncheon on Wednesday, Oct. 2, by Rear Admiral M. L. Deyo, Commandant, First Naval District, Boston, Mass.

The war demonstrated, he said, that "this country, without an undue amount of regimentation, produced an unheard of amount of war material. In this the people showed a willingness to pull together unprecedented in our history. This is indeed a significant lesson at a time when the tendencies are to pull apart. To pull together in time of peace is not easy or popular, but if we do so, and present a united front to the world, I doubt that we would have to fear another war."

He listed New England's contributions as follows:

Machine tools, especially significant in the early days of the war, when the whole world was relying so heavily for its very existence on the battle of American production.

More than one third of all combatant ships, and many merchant ships, came from the shipyards of New England, beginning June 1, 1940.

The contribution of planes and plane parts to the war machine was worth more than $4,500,000,000, of which over two billion was for the Navy.

Ordnance contracts awarded by the Services to New England amounted to over $3,900,000,000 and since June 1, 1940, the area contributed more than 11 per cent of the national total of guns and ammunition.

Contracts for electronic equipment amounted to about $1,000,000,000.

The area played a prominent part in producing apparatus for submarine detection.

Research and development of new techniques in New England's technical schools were of inestimable value.

The contribution of machinery was great. Contracts for metal products alone totaled more than $725,000,000.

New England textile and leather-goods firms received contracts for clothing for ship and plane crews of about $3,000,000,000, or nearly 30 per cent of the nation's total.

Agricultural production in New England for the war years was over $1,200,000,000. For example, the 1943 Maine potato crop was 70 per cent above the state's average for the previous ten years. Fish amounted to over 4,000,000,000 pounds.

The Navy's need for wood and wood products was heavy. The area contributed over 10,000,000 cords of pulp wood and 5,200,000,000 board feet of lumber, in spite of the loss of almost half the previous available labor.

Transportation and communication systems gave great aid in getting material as well as personnel to their destinations. Long-distance telephone calls rose to 40 per cent over the prewar 1940 average.

Power production of the area rose from an average in the five years before the war of about 7,500,000,000 kilowatthours to a wartime annual average of 10,500,000,000.

In conclusion Admiral Deyo declared that the technical men of the region "who did so much of the planning and integrating necessary to spark this huge effort and keep it rolling smoothly" merit the special thanks of the nation. He challenged them to "take action toward the realization of better government and better citizenship."

Alton C. Chick, member A.S.M.E., vice-president, A.S.M.E. Region I, assistant vice-president and engineer, Manufacturers Mutual Fire Insurance Company, Providence, R. I., was toastmaster.

Banquet

As always, the big social event of the four-day meeting was the banquet, on Wednesday evening, Oct. 2, at which Ralph E. Flanders, fellow A.S.M.E., president, Jones and Lamson Machine Company, Springfield, Vt., was the toastmaster. He turned the meeting over to President Yarnall who presented a fifty-year gold button to Arthur L. Williston, retired, Dedham, Mass.

R. E. Flanders and Irving E. Moultrop, construction engineer, Belmont, Mass., were then presented with certificates of honorary membership by President Yarnall for their outstanding contributions to engineering. L. W. Wallace, member A.S.M.E., vice-president, Trundle Engineering Company, Cleveland, Ohio, read the citations.

Following the presentations, President Yarnall introduced A. C. Klein, fellow A.S.M.E., engineering manager, Stone and Webster Engineering Corporation, Boston, Mass., who spoke on "Engineering in an Atomic Era."

Mr. Klein offered a glimpse into the future of atomic energy in the United States, both in its military and industrial implications. His address will be published in a later issue.

Military Aspects

Mr. Klein said in part: "The engineers' interest in the military aspects of atomic energy are vital, since to the extent that our plants must operate for military purposes, just to that extent are they hindered from producing material for peacetime purposes.

"No one who has gone through the engineering and development work which led to production of bombs can do other than to conclude that it will be a decade before any other nation can vie with us in atomic-

A. C. KLEIN SPEAKS ON ATOMICS AT THE BANQUET

bomb production. I venture to predict that our research program, if implemented with proper engineering development, will keep us in the forefront for a generation at least. During that time it behooves us to settle the international situation so that it will never again arise to threaten us.

"We have the bombs. We have the production facilities. We have the engineering know-how. We have the industrial plant to implement that know-how. It would be the height of folly for us to throw away the advantages which this position gives us, except on our own terms. The time has now come when we must go forward with a plan for the control of the atomic bomb based on associating ourselves with those nations which are favorably disposed to our plan."

Peacetime Applications

Concerning peacetime uses Mr. Klein said that the first commerical atomic-energy plants will be of the order of hundreds of thousands, perhaps up to a million kilowatts in size.

These first plants will be operated only by the largest consumers of power, as part of an interconnected network of several public-utilities systems. Only their continued operation for a period of many years, with improved design and operating techniques, will result in "cheap" atomic-power energy. It will be at least ten years before there will be any notable effect upon electricity costs. This source of power will supplant coal and other fuels to a limited extent only.

The production of radioactive materials for medical and biological purposes presents no outstanding difficulties and will continue on an increasing scale. Another important outgrowth lies in the field that has been opened up for the separation of isotopes, which may lead to important developments in chemistry and metallurgy.

Engineers' Responsibility

Specific recommendations on the engineers' role were made by Mr. Klein in closing. The American Society of Mechanical Engineers should add to its professional divisions a "Division of Atomistics," he declared, which

MRS. A. C. CHICK, MR. CHICK, AND MRS. EUGENE O'BRIEN AT THE BANQUET

would "prove the rallying post for the thousands of our members who contributed to the atomic-bomb development."

Study of the Atomic Energy Act of 1946 should be undertaken so that the profession can voice its recommendations for personnel and rules of procedure of the Atomic Energy Commission. Of the nine members of the general advisory committee of the Commission, to be appointed by the President, at least five should be engineers, the speaker advocated.

"This is no job for individuals. It is a job to be undertaken by The American Society of Mechanical Engineers and its fellow engineering societies. It is a job to be well and carefully planned and then to be prosecuted with all the organized might of the engineering profession."

A reception and dancing followed the speaking program.

Power

The final social event of the meeting was a luncheon held Thursday, Oct. 3. H. A. Winne, member A.S.M.E., vice-president in charge of engineering policy, General Electric Company, Schenectady, N. Y., spoke on "Power—Where Do We Go From Here?" Eugene O'Brien served as toastmaster.

Reviewing the tremendous advances made in the generation of power from fuel, particularly that for public utilities, Mr. Winne traced the increased efficiency and decreased coal consumption through the use of higher steam pressures and temperatures.

The trend toward higher pressures and temperatures took the country by storm, so rapidly and so effectively that in the last 20 years the coal consumption of the best plants has decreased almost two thirds, to about three quarters of a pound per kilowatthour. In fact, the average coal consumption of the country is now only about $1^1/_4$ lb per kwhr.

Another development in recent power history was the Emmet mercury-vapor process, proposed to the engineering world before the first World War by W. LeRoy Emmet. It was his contention that by the use of two working fluids in the power-plant cycle, the one, mercury, supplying the leftover heat to the other, power-plant thermal efficiencies could be improved. Initial experimental installations proved this correct.

Mr. Winne remarked that the gas turbine will profit greatly in the next decade from the indubitable progress in metallurgy and aerodynamics which lies before us. Perhaps the eventual power unit will resemble only slightly our present version; it may be a completely closed cycle, it may be a semiclosed cycle, or, in fact, it may turn out to be the simple open-cycle unit, having modest efficiency and no water consumption. Only a prophet can forecast which type will be most in demand by users. Even an engineer, however, can prophesy that this modern internal-combustion turbine will find many and broad fields of usefulness in all technical fields where power is required.

Looking to atomic energy as a possible source of power in the future, Mr. Winne said, "Personally, I believe that in the course of time production of electrical power from atomic energy will become an important factor. But in my estimation that time is considerably more than 10 years away—quite possibly two or three decades. And the introduction of atomic power into our economy will, I believe, be very gradual and not at all upsetting to our present utility industry. I look for atomic energy to supplement and complement our present power sources—not to replace them."

Inspection Trips

Nine historic and technical inspection trips

AT THE BANQUET

(*Left:* R. E. Flanders, past-president A.S.M.E., and toastmaster at banquet. *Center:* I. E. Moultrop (*left*) receives certificate of honorary membership from President Yarnall (*right*) as L. W. Wallace (*center*) looks on. *Right:* Arthur L. Williston, recipient of 50-year gold button, and Erik Oberg talk it over after the banquet.)

A.S.M.E. GROUP INSPECTS TURBO-JET ENGINE WHILE TOURING THE GENERAL ELECTRIC COMPANY'S RIVER WORKS

were planned for the visitors, and approximately 600 members and guests took the opportunity to make them. On Monday morning, Sept. 30, historic trips about Boston were conducted.

Quincy Market

On Monday afternoon 72 members went on a trip to the Quincy Market Cold Storage and Warehouse Company, one of the oldest and largest of its kind in the world. At this plant, refrigeration is produced for the extensive underground pipe-line system which feeds some seven hundred customers throughout the Boston Market district. The visit included inspection of a cold-storage warehouse which is refrigerated from centralized coil rooms, operated by an ammonia booster plant using the pipe-line refrigeration system for the second stage.

E. B. Badger and Sons

After the trip through the Quincy Market the visitors were taken to the experiment station of E. B. Badger and Sons where they saw the Kleinschmidt vapor-compression evaporator which produces high-purity distilled water from Boston Harbor water.

The unit consists essentially of an evaporator, a heat exchanger used to preheat the incoming feedwater and cool the condensate and blowdown, a vapor compressor which adds heat to vapor for producing the distilled water, together with various motors, pumps, and control equipment.

Maverick Mills

The trip to Maverick Mills, East Boston, Mass., took 120 men and 10 women through one of the most up-to-date mills in the country with progressive management based on effective textile-engineering methods. The group saw voiles, lawns, dimities, semifancies, all-combed gray goods, and fine yarns in the process of manufacture.

General Electric Company

On the afternoon of Oct. 1, the River Works plant of the General Electric Company in Lynn, Mass., was host to 220 visitors at a luncheon which was followed by an inspection tour of the plant. To make the tours of most value to the visitors, five different trips were arranged and visitors could select the one in which they were most interested.

Jet engines. Due to the universal interest in jet engines, each tour was taken through the building in which the first jet engine in the United States was first operated. An I-16 engine was started and operated with the test cell doors open for the benefit of the visitors. On display were cutaway full-size engines for the I-16 which is used in the Army P-59 Fighter and the Navy FR-1 Fighter. The P-80 Shooting Star power plant, an I-40, was seen in cutaway form along with an exhibit of the various components of the I-40. Power plants for the latest Army and Navy airplanes were seen in a TG-100 Prop-Jet mockup and a TG-180 Turbo-Jet production engine. Turbo-superchargers, geared impellers, accessory test apparatus, and demonstration of rotor balancing technique completed the Aircraft Gas Turbine Division's exhibit.

Electric motors. Those primarily interested in electric motors took a tour which followed the production lines of a-c and d-c motors, in sizes ranging from 1 to 60 hp, from the incoming raw stock to shipment of finished motors.

Steam turbines. Visitors on this tour saw many of the manufacturing and test facilities for the production of steam-turbine generator sets 500 to 10,000 kw in size and of turbine sets for ship propulsion in sizes up to 13,500 hp. The group also saw a great number of 1500-lb steam supply lines.

Reduction gears. This group saw worm gears, pump gears, all types of transportation and industrial gears as well as high-speed, double-reduction-gear units in ratings up to 53,000 hp being manufactured and tested. Of particular interest to the visitors were the facilities for machining, hobbing, lapping, balancing, and inspecting gear rotors up to 200 in. in diameter and 50 tons in weight.

Iron foundry and fabrication. Those taking this tour saw intricate castings weighing 25,000 lb being made in flasks as large as 12 × 16 × 8 ft. They also saw mechanical molding units making castings for a-c and d-c motors.

The fabrication shop where casings, stator frames, and other turbine and generator parts as well as the casings and parts for the highest-

PRESIDENT YARNALL POSES WITH BANQUET SPEAKERS AND GUESTS

(*Left to right:* Top row: A. C. Chick, C. W. MacGregor, C. E. Davies, L. W. Wallace, H. A. Winne, H. M. King; Bottom row: A. C. Klein, R. E. Flanders, D. Robert Yarnall, I. E. Moultrop, and E. W. O'Brien.)

capacity ship-propulsion gears in the world are made was also visited.

Power plant. This trip afforded visitors the opportunity to see the complete water conditioning and feedwater-heating system for an industrial plant having a generating capacity of 31,000 kw and a wide range of steam demand at pressures from 3 to 1500 psi gage which is used for process and testing. Boilers operating at 1500 psi, 900 F, and the 5000-kw "topping" turbine which they supply were examined.

Harvard University

Harvard University, the oldest institution of higher education in America, was visited on Tuesday, Oct. 1. Many of Harvard's fine buildings such as the Chapel, Houghton Rare Book Library, Fogg Art Museum, first reinforced-concrete stadium built in this country (1902), the University Museum, housing many fine collections, including the world-famous collection of glass flowers, and the Computation Laboratory which houses the Automatic Sequence Calculator, were visited.

Also on Tuesday afternoon the Wood Industries group sponsored a trip to the S. A. Woods Machine Company. Sixteen members attended.

B. F. Sturtevant Company

Sixty-six members made the inspection trip to the B. F. Sturtevant Company (division of Westinghouse Electric Corporation). They were served a lobster luncheon in the plant cafeteria after which a sound slide-film entitled "What Sturtevant Makes" was shown to introduce the varied products of the division.

During the tour of the works, the visitors were taken to the Industrial Systems Research Laboratory where new-type vacuum driers and related equipment were demonstrated. They were also taken to the Fan Research Laboratory where the intricacies of fan development and testing were explained.

In the main fan shop, the members were most impressed by the wide range of fan sizes. Fans shown included a 3-in-diameter multivane fan used for cooling radar tubes and a 90-in. fan used for induced draft.

The tour ended in an exhibit room where many products of the company were displayed.

Massachusetts Institute of Technology

A group visited Massachusetts Institute of Technology Wednesday afternoon, Oct. 2, and saw the Center of Analysis "Differential Analyzer," Mechanics of Materials Laboratory, Laboratory of Experimental Stress Analysis, Wright Wind Tunnel, and other points of interest.

Mystic Station

On Thursday afternoon, approximately 75 visitors toured the Mystic Station of the Boston Edison Company. This station represents one of the most recent 1200-lb, 900-F, straight-through condensing power stations. The group saw two 50,000-kw turbogenerators and two 430,000-lb per hr boilers in operation. A third 50,000-kw unit is now under construction. The visitors then inspected the screen house, the yard coal-conveying system, the boilerhouse, the turbine room, and the switch house.

RECEPTION LINE AFTER THE BANQUET

Technical Sessions

Nearly 1200 A.S.M.E. members and guests took part in one or more of the 21 sessions at which 49 authors presented 34 individual or joint technical papers on such subjects as heat transfer, management, hydraulics, industrial oil firing, packaged boilers, industrial relations, emergency housing, industrial packing, wood waste, molded plastics, underfeed stokers, production engineering, textiles, turbojet engines, education and training, metals engineering, aircraft-seat comfort, aircraft safety, powder metallurgy, coal-feeding mechanisms, water treatment, automatic control systems, servomechanisms, and cutting fluids. The most popular session, according to the number present, was the one on Education and Training, Tuesday evening, at which 151 heard C. W. Ranson speak on the professional and economic position of the engineering profession, and R. L. Forshay on collective bargaining for professional personnel. W. F. Ryan, fellow A.S.M.E., I. M. Stein, member A.S.M.E., and S. Gilman were among the discussers. At a simultaneous session of the Aviation Division (Gas Turbines) more than 120 heard Charles A. Meyer, junior A.S.M.E., speak on the characteristics of turbo-jet engines at high flight speeds, in which he declared that so far as scientists can tell from present experiments, turbo-jet engines should be able to travel 1152 mph or better. The discussion revealed that aircraft manufacturers will have to catch up with the turbo-jet engines before such flights are possible. While the engine faces no basic difficulties, manufacturers will find it difficult to construct planes that will hold together at such great speeds.

Textiles

That New England is famous for its textile industry was indicated by the large group which attended the Textile session Tuesday afternoon. Nearly 150 heard Simon Williams give a brief survey of plastic materials and the types suitable for manufacture into fabricating films and the influence of these properties upon the films and their fields of usefulness. On the same program Albert G. H. Dietz, speaking on integral plastic problems, said that the development of nonwoven textiles during the last ten years has centered largely around the use of cotton fibers as a base material. He also intimated that new developments indicate the possibility of the formation of completely randomly oriented webs by aerodynamic techniques on a continuous basis.

Collective Bargaining

Turning their attention to the current crisis in collective bargaining, engineer-managers on Tuesday morning heard Martin B. Horan declare that "instead of calling labor the enemy of free enterprise we must recognize state control as the real enemy." He also stated that labor and management, instead of working against each other, should regain the initiative and work together against increasing state control. Speaking before the same group Dr. Philip Taft said that discipline and carrying out of agreements must be the cornerstone upon which collective bargaining and the labor movement rest. He contended that labor unions in the United States are essentially conservative in philosophy but very vigorous in seeking their demands. He stated further that "with the greatly increased importance of labor unionism in our economy, the unions must recognize that they share, with management and government, a responsibility for a healthy economy. Policies must be designed that will enable us to continue to enjoy a high level of employment and national income. A severe decline in employment and income will not only affect union membership and union income, but one of the strategic groups in our economy, labor, will bear, in the minds of the public, some share of the blame for the hardships that will follow. Labor unions are regarded as having an important voice in the shaping of our economy, and they are likely to suffer severely if it begins to slide downward to low levels.

Emergency Housing

At the Wood Industries Session Monday evening Prof. Walter C. Voss spoke on another subject of current interest to all, emergency housing. Professor Voss indicated that the middle-income group ($2000-$5000) have the greatest interest in emergency housing. He remarked that costs must be reduced by lowering material prices and that this can be realized only by higher productivity of labor. A drastic revision of outmoded building codes is necessary in order to use the new materials on hand. Unions must co-operate in the future by: (1) eliminating compartmentization; (2) more efficient production; and (3) doing

EUGENE O'BRIEN AND HARRY WINNE IN SERIOUS CONVERSATION BEFORE LUNCHEON ON THURSDAY

away with high split wages to be replaced by a yearly income wherever possible. He also stated that engineering improvement is necessary. Houses should be designed as units instead of individual members, to take advantage of increased strength produced by fabrication.

Joseph A. DeLuca, also on this program, presented a paper which covered a method by which one can determine the most effective way of packaging a given product. A third paper describing the many uses of plywood in boat construction was presented by F. W. Hagerty.

Wood-Waste Utilization

Utilization of wood and wood waste, important in many New England industries, was the subject of a paper presented by Robert S. Aries at the Wood Industries session on Tuesday morning. The audience attending this session heard an estimate that each year in American forests more than two thirds of the forest drain is lost during manufacture and use. Mr. Aries said that the wood-industry field is worthy of more attention by engineers and that now is the time to introduce adequate manufacturing techniques, utilize wastes, and develop new products. He emphasized the need for the application of adequate quality control and segregation throughout manufacturing processes and said that the special requirements of numerous wartime products called for the establishment of new standards of precision in many woodworking industries.

A partial solution to the pressing problem of what to do with the existing wood-waste production was seen in the use of wood-resin combinations. Some new methods that have been developed for this new field of plastic molding were described by Robert A. Caughey on the same program. A third paper on the uses of lignin in agriculture was presented jointly by Stuart Dunn and Joseph Seiberlich.

Hydraulics

At the Hydraulic session on Monday afternoon, two interesting papers concerned with laboratory investigations in the field of experimental hydraulics were presented.

The first paper, entitled "The Shock Produced by a Collapsing Cavity in Water," by M. F. M. Osborne, discussed experiments aimed at obtaining quantitative measurements of shock caused by cavitation and compared the results with theory. The second paper, presented by Prof. Philip Ullyott, was entitled "Investigation of Flow in Liquids by Use of Birefringent Solutions of Vanadium Pentoxide." The results of the method were illustrated by colored movies.

Metals Engineering

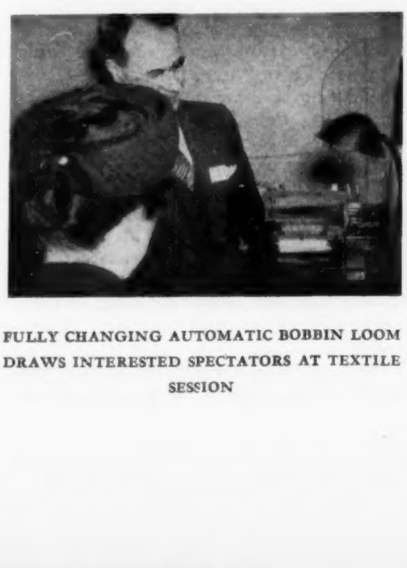
C. R. Austin, in a paper which he presented at the Metals Engineering session Tuesday evening, reviewed the factors associated with the selection of iron in relation to the section to be cast. He gave basic engineering data comparing different types of iron, and he discussed, using slides, the use of iron castings in engineering production. Also at this session J. H. Goss gave a short and interesting talk on typical new applications of magnetic materials which are of interest to mechanical engineers. He discussed the fundamental properties of magnetic materials and traced their development. Mr. Goss also compared magnetic properties and cost to the magnetic output. His compilation contained a number of recent developments which have especially interesting and attractive properties.

Fuels

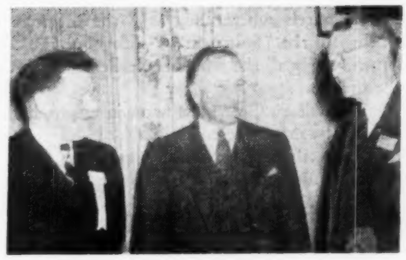
Twenty years of progress in industrial oil-firing was reviewed by Rene J. Bender at the Fuels session Monday evening. His paper described the contribution of the U. S. Navy to the progress in the utilization of residual fuels, the study of the compatibility of these oils, adoption of the heater test and oxidation test, and the study of the ash problem. A description of the three main types of industrial oil burners followed. Martin Frisch, at this same session, reviewed the principles guiding the design of easily transportable packaged boilers. These are designed to be shipped wholly or partially shop-assembled, for quick set-up with a minimum of erecting and labor at the site, to meet temporary or extended local needs for steam.

Airplane-Seat Comfort

In another session sponsored by the Aviation Division Wednesday morning, Francis E. Randall presented the results of Army Air Forces studies carried on to determine the requirements for adequate seating for aircraft pilots. He discussed the research techniques employed, as well as the special test seat developed for the studies. He pointed out that although the principles evolved have thus far been used only in connection with aircraft seating, they may be applicable to any type of seating requirement. The major engineering problem encountered was that of developing a means for proper cushioning. This problem still remains, and it is urged that the studies be continued until an adequate solution is provided. A second paper read at this meeting by Paul M. Fitts presented data on psychological problems in aircraft-equipment design which had been collected in 100 recorded interviews with experienced pilots. Each individual interviewed was asked to describe in detail a number of personal experiences in which he had difficulty in using equipment, in which he had more to do than he could handle, or in which he made an error in the use of controls or the interpretation of instruments. Take-off, landing, and instrument-flight problems were covered. The results of a systematic analysis of these actual flying experiences were reported by Mr. Fitts.



FULLY CHANGING AUTOMATIC BOBBIN LOOM DRAWS INTERESTED SPECTATORS AT TEXTILE SESSION



Left to right: H. M. KING, F. S. BLACKALL, JR., AND PRESIDENT YARNALL

Cutting Fluids

Beginning with the cutting fluids that were commonly employed thirty or forty years ago, such as lard oil, straight mineral oil, soda water, and soap water, A. O. Schmidt, at a joint Metal Cutting Data and Production Engineering session Thursday morning, traced the development of cutting fluids through the mineral lard oils, the sulphurized mineral oils, the sulphurized fat bases, and the various chlorinated additives to the synthetic additives of the present day. Following this paper, James T. Beard spoke on the trends in the development and application of cutting fluids.

Space does not permit reviewing all the papers presented at this meeting. However, as the publication schedules of MECHANICAL ENGINEERING, A.S.M.E. Transactions, and the *Journal of Applied Mechanics* permit, many of these papers with their discussion will be published.

The Women's Program

An interesting and entertaining program for the visiting women was arranged by the Women's Committee of the A.S.M.E. Boston Section, under the chairmanship of Mrs. C. H. Berry. On Monday afternoon, Sept. 30, the women visted the University Museum, Harvard University, where they saw the Blaschka glass flowers. Following this they went on a short tour of Harvard Yard. Later in the afternoon 43 of the women went to the home of President Karl T. Compton, where they were guests of the Massachusetts Institute of Technology for tea. Mrs. Compton was the hostess. Monday evening was taken up with informal bridge parties.

Tuesday morning, Oct. 1, saw the women off for a drive through Lexington and Concord where they stopped briefly at the battlegrounds. They had luncheon at Longfellow's Wayside Inn, South Sudbury, Mass. On the return trip the women stopped and visited the Governor Gore Museum, Waltham, Mass.

Thirty-five women went for a trip up the North Shore to Salem on Wednesday, Oct. 2, where they visited the House of the Seven Gables. A luncheon party was then held at the Stephen Daniel House. In the afternoon they visited the King Hooper House, Marblehead, where they saw an interesting display of pottery. The women also visited St. Mi-

chael's Church where they saw the original painting of the "Spirit of '76" in Abbot Hall. In the evening all the women attended the banquet and dance.

On Thursday, Oct. 3, the women enjoyed a musicale by Mrs. Helen C. Bedford, harpist, who gave them a charming program. A luncheon followed.

Committees

Members of the committees of the A.S.M.E. Boston Section who worked hard to plan and organize the 1946 Fall Meeting were:

General Committee: H. M. King, chairman, C. B. Seelig, secretary, Kerr Atkinson, E. L. Root, R. L. Williams, F. L. Farrell, C. R. Westerway, W. F. Ryan, H. S. Houghton, G. K. Saurwein, F. M. Carhart, S. S. Perry, E. K. Bancroft, G. A. Orrok, Jr., H. L. Von Rehberg, E. MacNaughton, I. E. Moultrop, R. D. Stauffer, H. N. Dawes, H. J. Brown.

Technical Events: Kerr Atkinson, chairman, Joseph W. Zeller, vice-chairman, C. H. Berry, A. W. Bollenback, David A. Fisher, James Holt, E. J. Wisemann.

Inspection Trips: G. K. Saurwein, chairman, James Holt, vice-chairman, R. E. Sherbrooke, George P. Lunt, J. J. McElroy, W. B. Wilson, R. A. Spence, J. N. Calhoun, G. A. Orrok, Jr.

Registration: S. S. Perry, chairman, E. K. Bancroft, R. F. Metcalf, H. S. Frederick, T. A. Fearnside, O. S. Pike, W. B. Goodard, P. W. Dalrymple, R. G. Hastings.

Reception: I. E. Moultrop, chairman, Edgar MacNaughton, vice-chairman, H. N. Dawes, F. M. Gunby, A. C. Klein, J. W. Zeller, A. W. Benoit, B. B. Folger, Sr., E. L. Nute, G. K. Saurwein.

Entertainment: W. F. Ryan, chairman, H. S. Houghton, vice-chairman, H. H. R. Spofford, Robert A. Spence, J. T. Croghan, C. M. Durgin.

Student Group: H. J. Brown, chairman, F. A. Stearns, W. M. Murray, D. A. Fisher.

Hotel: F. L. Farrell, chairman, C. E. Westaway, vice-chairman, C. P. Klimas, W. J. Dunn, M. W. Roberts, E. Hinton, M. Freeman, R. T. Forbes, O. Pike, H. B. Wallace, J. Ryder.

Printing and Signs: E. L. Root, chairman, R. L. Williams.

Publicity: G. A. Orrok, Jr., chairman, J. L. Von Rehberg.

Women's Committee: Mrs. C. Harold Berry, chairman, Mrs. Joseph H. Keenan, vice-chairman, Mrs. Sabin Crocker, Jr., Mrs. Howard W. Emmons, Mrs. Hoyt C. Hottel, Mrs. Harold M. King, Mrs. Edgar MacNaughton, Mrs. George A. Orrok, Jr., Mrs. E. V. Pollard, Mrs. James A. Powell, Mrs. George K. Saurwein, Mrs. J. F. Downie Smith, Mrs. R. G. Standerwick, Mrs. Donald Warner.

Army Demonstrates Arms at A.O.A. Annual Meeting

A DEMONSTRATION of the might of American arms was staged at the Aberdeen Proving Grounds, Aberdeen, Md., by the Army Ordnance Department for more than 7000 civilian members of the Army Ordnance Association, who assembled there on Oct. 3, 1946, for the 28th Annual Meeting of the Association, the first since the start of World War II. The demonstration gave impressive evidence of the teamwork, of American science, industry, and the Armed Forces.

Wm. W. Coleman, president, A.O.A., welcomed the members of the Association and in his address pointed out that this was their first meeting of the Atomic Age. He stressed the need for close co-operation between American science, industry, and the Armed Forces and renewed the pledge of loyalty to national defence on the part of the Association.

Major General E. S. Hughes, Chief of Ordnance, greeted the visitors and pointed out that more than ever industry must accept its share of the responsibility for preparedness. He voiced the general feeling that if and when there is another war, it will come without warning and that the safety of the nation depends on preparedness.

Brigadier General A. B. Quinton, Jr., commanding officer, A.P.G., welcomed the members of A.O.A. and expressed appreciation of the aid to national preparedness rendered by the association. He called for a continuation of the closest co-operation between industry and government in research and development, which he considered the "backbone of the future."

The morning was devoted to a review of motorized equipment. The approach of the column from the far end of the "Main Front" was an impressive sight as the long line of wheeled vehicles and self-propelled weapons, tanks and tank transports approached the stands. A touch of realism was attained by the discharge of artillery during the approach. All classes of equipment were included from the $^{1}/_{4}$-ton jeep to the motorized 155-mm "King Kong." Various forms of swimming devices were included.

The afternoon was devoted to a display of the effectiveness of the different types of equipment. The latest models of small arms, rifles, submachine guns, grenades, and aircraft weapons were described and fired. Mortars ranging from the 60-mm M19w/base plate TI mortar, developed as a lightweight hand-held weapon, up to the 250-mm T6E3 mortar for use against permanent fortifications made close-range fighting very realistic.

Bombing by airplane at low altitude demonstrated the various types of bombs used and proved the importance of this method of attack. The plane approached from behind a row of trees, dropped its bombs, and was gone so quickly that it would not seem possible to offer any defense.

Light artillery was fired against targets at a range of approximately 2000 yd. While this distance was well within the range of these howitzers their accuracy was well demonstrated.

The long range of the heavy artillery prevented a demonstration of its effectiveness. The pieces were discharged so that the visitors obtained some idea of their power.

The demonstration closed with a 30-second barrage, during which all of the pieces on display were fired. It is reported that in one case, such a simultaneous massed firing on a predetermined target cost the Germans 28,000 killed in a period of 48 hours.

1947 Officers of A.S.M.E. Elected by Letter Ballot

AS reported by the tellers of election, William G. Christie, F. M. Gibson, and C. W. Obert, letter ballots received from members of The American Society of Mechanical Engineers were counted on Sept. 24, 1946. The total number of ballots cast was 6871; of these 65 were thrown out as defective.

	Votes for	Votes against
For President		
EUGENE W. O'BRIEN	6768	38
For Regional Vice-Presidents		
To serve 1 yr		
ALTON C. CHICK	6782	24
To serve 2 years		
A. R. MUMFORD	6792	14
E. E. WILLIAMS	6791	15
T. S. MCEWAN	6788	18
LINN HELANDER	6790	16
For Director at Large		
To serve 4 years		
F. S. BLACKALL, JR.	6789	17
B. V. E. NORDBERG (deceased Aug. 19, 1946)	6789	17
To serve 2 years		
L. F. MOODY	6799	7
W. A. CARTER	6799	7
Miscellaneous	25	

The new officers will be introduced and installed in office during the Sixty-Seventh Annual Meeting of the Society to be held at the Hotel Pennsylvania, New York, N. Y., Dec. 2 to Dec. 6, 1946.

Biographical sketches of the newly elected officers were published in the August, 1946, issue of MECHANICAL ENGINEERING, pages 757 to 762.

Strikes Cause Cancellation of A.S.T.E. Meeting

BECAUSE of the power, hotel, and other strikes, which virtually shut down the city of Pittsburgh, Pa., the American Society of Tool Engineers canceled its semi-annual meeting scheduled for Oct. 10–12, 1946, and transferred the business sessions of its board of directors and various committees to the Fort Shelby Hotel, Detroit, Mich., Oct. 25–27, 1946.

The last-minute cancellation was accomplished by means of a mass telegram sent to eighteen thousand members of the society.

The next national meeting of the A.S.T.E. will be in Houston, Texas, in March, 1947.

First National Meeting of I.I.R. Division Marks Milestone in A.S.M.E. Growth

Four Technical Sessions—14 Papers Presented

THE contribution of the mechanical engineer to the art of industrial process control and his responsibility in the preservation and further development of the "know-how" that has made this nation industrially great were hailed by more than 300 engineers and guests who participated in the first national meeting of the Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers held at the William Penn Hotel, Pittsburgh, Pa., Sept. 16 to 18, 1946, in co-operation with the Instrument Society of America.

The meeting was an auspicious one for the A.S.M.E. I.I.R. Division because it climaxed ten years of activity in the field of instrumentation. The division was first organized as the Committee on Instruments and Regulators of the Process Industries Division in 1936, and later in 1943 it attained the status of a professional division. Signalizing the rapid growth of the instrument industry, the I.I.R. Division has today more than 1200 members active in many sections of the Society.

D. Robert Yarnall, president A.S.M.E., speaking on behalf of the Society, congratulated the officers and members of the Division and said that the Pittsburgh meeting was "an important milestone in the development of our Society."

Admiral de Florez Speaks

The high point of the social program was the I.I.R. Division banquet held in the English Room of the Fort Pitt Hotel, Monday, Sept. 16. In spite of the threatening meat shortage the committee was able to arrange for a roast-beef dinner. Two hundred members and guests were present.

Following an introduction by toastmaster R. J. S. Pigott, fellow A.S.M.E., chief engineer, Gulf Research and Development Company, President D. Robert Yarnall spoke briefly to congratulate the Division on the success of its first national meeting. He called attention to the continuing wartime trend of co-operation between scientists and engineers and gave a short account of his recent trip to the West Coast during which he was privileged to inspect the laboratory of E. O. Lawrence, Nobel prize winner and recipient of the A.S.M.E. Holley Medal.

President Yarnall was followed by Luis de Florez, member A.S.M.E., rear admiral, U. S. Navy, assistant chief, Office of Research and Development, who spoke on "Instrumentation of the Future."

Admiral de Florez laid aside his prepared paper and spoke freely and informally about his vast wartime experience with instruments used on aircraft. With a twinkle in his eye and with a ripe facility of phrase, he captivated his audience by recounting incidents that carried home some of his basic ideas.

He said that instruments have been so highly developed that it is no longer necessary to worry about accuracy or the reliability of instruments in obtaining information needed for the control of a mechanism as complex as that of an aircraft. The need now is a new way of presenting the mass of information that pours into a control station so that it can be grasped by an average mentality.

The traditional use of dials and pointers, all using different scales and moving clockwise and counterclockwise, makes an aircraft control panel at night look like an animated Christmas tree, he said. Even experienced fliers who have been grounded for a few weeks find it difficult, on resuming flight, to interpret the mass of information presented in this manner.

Admiral de Florez suggested that instruments should be designed to facilitate interpretation of their readings. Instead of a confusing array of dials and indicators requiring mental gymnastics for their interpretation, he said that instrument readings should be grouped in such a manner that reaction to them could be instinctive. He said: "A trend is developing in the direction of obtaining vertical-reading instruments where a number of variables can be compared by the vertical height of the indicators. By choosing a suitable scale of the variables, correct operation can be improved by having all vertical readings in a line. Such an instrument is now being tested for the engine panel in aircraft. The pressure manifold gage, oil temperature, oil pressure, fuel pressure, carburetor air, and multiples of these instruments are arranged to read in vertical columns of the dial. The scale of each instrument is so proportioned that under cruising conditions the readings are in a straight line. If the throttle is moved to climb or cut, other instrument readings will assume a straight line if correct operation is maintained. Any deviation from a straight line is immediately noticed and subject to correction. Thus less attention and judgment are required and correspondingly less fatigue results."

A color film of the two Bikini atomic-bomb tests, not yet released to the public, was shown following Admiral de Florez's talk. The film had been flown from Washington, D. C., by Admiral de Florez and was not yet fitted with sound. Admiral de Florez, who had been at Bikini, gave a running commentary of the events depicted on the screen.

Instrument Exhibit

The entire seventeenth floor of the William Penn Hotel was devoted to an exhibit of instruments. The latest products of 99 instrument manufacturers were on display. The exhibit was sponsored by the Instrument Society of America.

Combustion Control

A symposium on the controllability of combustion processes, attended by 180 engineers, opened the technical program. Under the chairmanship of E. G. Bailey, fellow A.S.M.E., vice-president, Bailey Meter Company

AT THE FIRST NATIONAL MEETING OF THE I.I.R. DIVISION IN PITTSBURGH, PA., MONDAY SEPT. 16, 1946

(*Left to right:* Ed S. Smith, chairman, I.I.R. Division; Luis de Florez, rear admiral, U. S. Navy; J. C. Peters, secretary, I.I.R. Division; Joel H. Hirsch, Gulf Research and Development Company; and J. W. Jacobson, general chairman of the I.I.R. Division Pittsburgh meeting.)

and The Babcock and Wilcox Company, four speakers discussed various phases of the combustion controls used on power boilers, open-hearth furnaces, and blast furnaces.

Joseph A. Pelletere, engineering and construction department, Gulf Oil Corporation, discussed achievements of combustion control from the point of view of boiler-room practice. He spoke on the subject "Uncontrollability Factors in Boiler Practice." Among the factors that tend to hamper combustion control as applied to steam boilers, Mr. Pelletere listed the following: The time lag of a control circuit; unusual designs of control valves dictated by considerations other than those required by the control engineer; inherent operating characteristics of a boiler, such as water-level surge during rapid changes in firing rate; difficulties of accurate sampling of flue gases.

Because instrument manufacturers have attacked and overcome these factors, instrument controls in the field of boiler-room practice have arrived at a high state of development, he said.

"Anyone who encounters a new instrumentation problem," Mr. Pelletere advised, "should first endeavor to check whether commercial boilerhouse controllers have not already encountered and conquered the problem, before embarking on what would seem to be a new field of research."

Open-Hearth Furnaces

The experience of the Bethlehem Steel Company with combustion-control problems encountered in the control of its open-hearth furnaces was described by A. J. Fisher, fuel engineer, Sparrows Point plant, Bethlehem Steel Company, in a paper on "Items of Controllability in the Open Hearth Combustion Process."

Mr. Fisher stressed the advantages of uniformity of controls when multiple units of the same process are to be controlled. At the Sparrows Point plant, he said that, "all control boards and all controls are the same on all furnaces so that a furnace operator is at home on any one of the 26 furnaces" operated at that plant. In addition to uniformity, he said, "any well-engineered control system will soon become inoperative" unless the control system is supervised by combustion engineers who have at their disposal adequate maintenance facilities. His paper described step by step the important features of the open-hearth-furnace combustion control which has been developed and time-tested at his plant.

Blast Furnaces

Another combustion-control problem complex enough to tax the ingenuity of instrument designers was presented by Walter N. Flanagan, member A.S.M.E., engineering consultant, Carnegie-Illinois Steel Corporation, in his paper on "The Possibilities of Closer Control of the Blast Furnace Through Additional Instrumentation."

Because of such factors as high temperatures, dirt, downward movement of huge masses within the furnace proper, fumes, erosion of instruments or their protective coverings, all encountered in the operation of a blast furnace, it has been impossible to obtain many measurements which could be very useful in control of the operation.

R. J. BENDER, SINCLAIR REFINING COMPANY, AND E. G. BAILEY, BAILEY METER COMPANY AND THE BABCOCK AND WILCOX COMPANY, AT THE I.I.R. DIVISION BANQUET, FORT PITT HOTEL, PITTSBURGH, PA.

While many instruments of special or universal design are in general used for blast-furnace control, the investment for such instrumentation appears to be modest compared to the 7 million dollar cost of the furnace and the 7 million dollar average annual cost of materials handled in the operation.

Mr. Flanagan concluded by saying that, "there is a wide field for the development of reliable commercial devices, recording as well as indicating, for use in blast-furnace control." Among the instruments needed by operators, he listed the following: Those for continuous dust determination; those for continuous analysis of gas giving CO, CO_2, and CO-CO_2 ratio; and those measuring temperatures of iron and slag within the furnace proper and while flowing.

The final speaker at the symposium was P. S. Dickey, member A.S.M.E., chief engineer, Bailey Meter Company, Cleveland, Ohio. He spoke on "Combustion Control and Its Influence on Fuel-Burning Equipment."

Mr. Dickey reviewed the history of combustion control and traced the development of the art to its present high state of perfection in boiler-room practice.

"Probably the most important contribution of combustion-control manufacturers to the science of automatic control," he stated, "is the 'know-how' of combining a number of different measurements of important variables into the multiple-element control systems necessary to regulate the combustion process."

The success of mechanisms and systems originally designed for combustion-control systems have encouraged their introduction into the field of industrial process controls.

Mr. Dickey concluded his talk by listing three factors upon which the quality of any automatic combustion-control system depended. He said that the equipment must be adaptable to control; the system must be designed to control all important variables; and control mechanisms must be rugged ands uitable for continuous operation for long periods.

Gas Analysis

The second technical session attended by more than 200 engineers was devoted to gas analysis instrumentation. A. W. Gauger, professor of fuels technology, The Pennsylvania State College, State College, Pa., discussed various methods of gas analysis and testing in a paper on "Principles of Quantitative Gas Analysis and Testing."

Professor Gauger defined analysis, as applied to a gas, as the science of determining the chemical composition of a gas or gaseous mixture and defined testing as the science of determining the values of some property of a gas or gaseous mixture. He described various methods of gas analysis, such as the volumetric method, the thermal-conductivity method, and the infrared-spectroscopic method. The advantages and limitations of each method were also discussed.

Professor Gauger stressed particularly the "convenience and usefulness of the mol as a unit in gas calculations" and illustrated the use of this unit in the solution of a typical problem in the study of a combustion process.

A precise method of engine-exhaust-gas analysis, developed in connection with a heat-distribution study on a full-scale aircraft engine by the Gulf Research and Development Company, was reported in a paper on "The Precision Analysis of Engine Exhaust Gas," by C. W. Butler, M. J. Boegel, and R. P. Jones.

Early in their study the authors found that a consistent error of appreciable magnitude was introduced into their heat-balance calculations when these were based on ordinary laboratory Orsat analyzer results. Upon recommendation of the U. S. Bureau of Mines, a modified Haldane apparatus was substituted for the Orsat analyzer with the result that heat-balance determinations were consistently obtained which were accurate within 1 per cent. Even with widely varying engine operating conditions, heat balances were obtained whose error rarely exceeded 2 per cent. The authors described the modifications made to the Haldane apparatus and the technique used to obtain precise analysis of exhaust gases.

In a paper on "N.A.C.A. Analysis for Aeronautical Engine Research," by H. C. Gerrish, mechanical engineer, and W. H. Haynie, physicist, both of the National Advisory Committee for Aeronautics, a new method of measuring fuel-air ratio on aircraft engines, developed by the Cleveland laboratory of the N.A.C.A., was described.

Fuel-oil ratio or mixture strength is an important factor in aircraft-engine performance because it affects engine temperature, specific fuel consumption, range, and load. A practical accurate method of determining this ratio under laboratory and flight conditions is an important research tool.

The new method is based on a proportional relation between the fuel-air ratio and the total carbon content of the normal exhaust gas. When normal exhaust gas is mixed with an excess of air and then oxidized, the resulting products are CO_2, water, and air, and the measure of the CO_2 is proportional to the fuel-air ratio. By using a thermal-conductivity type of instrument for measuring the CO_2, calibrated-to read directly in fuel-air ratios, a continuous-indication instrument can be made to give accurate fuel-oil ratios over a wide range of engine operation.

The paper describes the details of the new N.A.C.A. method and discusses use of this method in the study of mixture distribution on various types of aircraft engines.

Flow Measurements

The third technical session was given over to a discussion of flow measurement and control. This session was the most popular of the meeting and attracted an attendance of 290.

Considerations involved in an engineering study of multiple pneumatic control and regulation systems from the point of view of design was discussed by A. S. Markson, member A.S.M.E., and M. J. Boho, Hagan Corporation, in a joint paper on "Cascaded and Multiple Automatic Control Systems." The authors described three different kinds of systems, the apparatus used in each, and showed how the systems could be applied to specific control problems.

E. W. Jacobson, member A.S.M.E., Gulf Research and Development Company, in his paper on "The Positive Meter as a Flow-Rate Device," described several types of positive-displacement meters.

He said that positive meters were adaptable as flow controllers of mixing operations for two or more liquids and that they could be designed to drive auxiliary apparatus which could make such a mixing operation almost completely automatic.

New uses for the variable-area flow-rate meters called "Rotameters" were discussed by Victor P. Head, junior member A.S.M.E., fluids-research engineer, Fischer and Porter Company, Hatboro, Pa., in a paper, "An Extension of Rotameter Theory and Its Application in New Practical Fields." He predicted that with further standardization of float shapes and of flow coefficients, the Rotameter will eventually be included among the recognized standard flow-measuring techniques of the A.S.M.E. Power Test Codes.

The session was concluded by a paper by David B. Kirk, chief engineer, Moore Products Company, on "Nozzle Flow Characteristics in Pneumatic Force-Balance Circuits," in which he presented an analysis of a simple nozzle-diaphragm device used in control circuits to convert process variables to air pressure. Mr. Kirk showed how the simple device could be modified to give greater sensitivity, improve linearity of response, and make possible greater interchangeability of parts.

Automatic-Control Terms

A joint technical session with the Instrument Society of America was held on Wednesday morning, Sept. 18. In a paper on "Functional Analysis of Measurement Apparatus," H. C. Dickenson, General Electric Company, described a method of graphical analysis of instruments developed by his company.

Use of this method in the functional analysis of more than 100 instruments showed that only 92 basic elements had been used in the design of a wide variety of measurement instruments, he said. The method has the advantage of simplicity and clarity. Mr. Dickenson suggested that it may serve as a useful tool in the standardization of instrument terminology.

J. G. Horn, member A.S.M.E., Brown Instrument Company, read a paper on "Graphic Representation and Analysis of Automatic-Control Terms." This paper was written to supplement the work of the Committee on Terminology of the I.I.R. Division of the A.S.M.E., published in the February, 1946, issue of MECHANICAL ENGINEERING. The paper illustrated by means of thermal and fluid processes many of the terms used in the field of instrumentation.

Committees

The following committees were in charge of the meeting:

Industrial Instruments and Regulators Division, Executive Committee: Ed S. Smith, *chairman;* J. C. Peters, *secretary;* E. S. Lee, J. J. Grebe, and H. F. Moore.

A.S.M.E. Pittsburgh Section, Executive Committee: Tomlinson Fort, *chairman;* E. W. Jacobson, *vice-chairman;* Christian Wilson, Jr., *secretary;* K. F. Treschow, *treasurer;* Leo Tattersall, David Saylor, Herbert H. Hall, J. F. Mattern, T. J. Barry, and W. O. Lytle.

Arrangements Committee for Pittsburgh Meeting: E. W. Jacobson, *general chairman;* T. G. Beckwith, *general secretary;* and K. F. Treschow, *treasurer.* Technical Program: M. F. Behar, *chairman;* A. A. Markson, L. J. Van der Pyl. Entertainment: J. R. Aikens, *chairman;* T. J. Barry, A. H. Shafer, and Benj. M. Herr. Registration and Reception: T. O. Schrader. Publicity: T. G. Beckwith. Hotels: Harvey B. Mann and Christian Wilson, Jr.

William L. Batt Honored by I.M.E.

WILLIAM L. BATT, past-president and honorary member A.S.M.E., was formally inducted into The Institute of Mechanical Engineers as an honorary member at a special meeting of the Institute in London on Oct. 6, 1946. Dr. H. Guy, secretary, I.M.E., read the citation following which Mr. Batt signed the roll of honorary members.

The presentation ceremony was preceded by addresses by Mr. Batt and several distinguished British engineers on the progress being made in the United States and England toward the unification of screw-thread practice.

Mr. Arthur Woodburn, member of Parliament, joint Parliamentary secretary, Ministry of Supply, who introduced Mr. Batt, deplored the lack of screw standardization between the two countries, and said, "In many parts of industry this trouble has been overcome, but because in this instance the line of development in the two countries has been divergent we have this difficulty with screw threads. To the ordinary layman it almost appears as though there must be a screw loose somewhere! Mr. Batt has come over here to see whether he can get that screw tightened up."

In his address Mr. Batt reviewed the work of the Combined Production and Resources Board during the war and the results of the Conferences on Unification of Engineering Standards which were held in Detroit, Mich., and Ottawa, Can., in the fall of 1945. He said that a good deal of headway has been made and that a satisfactory solution of the problem was on the way.

Harry T. Woolson, member A.S.M.E., executive engineer, Chrysler Corporation, and C. E. Davies, secretary, A.S.M.E., accompanied Mr. Batt on the flight to England and were present at the special meeting of the Institute.

A.S.M.E Calendar

of Coming Meetings

December 2–6, 1946
A.S.M.E. Annual Meeting
New York, N. Y.

April, 1947
A.S.M.E. Spring Meeting
Tulsa, Okla.

June 16–19, 1947
A.S.M.E. Semi-Annual Meeting
Chicago, Ill.

Sept. 1–4, 1947
A.S.M.E. Fall Meeting
Salt Lake City, Utah

L. W. Chubb Named For John Fritz Medal

THE John Fritz Medal and certificate, the highest award in engineering, has been awarded to Lewis Warrington Chubb, director of the Westinghouse Research Laboratories. The award was made "for pioneering genius and notable achievements during a long career devoted to the scientific advancement of the production and utilization of electrical energy."

Dr. Chubb's contributions to the knowledge of magnetic properties of iron and iron alloys, and his improvements in the design of electrical machinery and in the measurements of electrical and magnetic quantities, have had great influence in the development of the electric arts during the past thirty years. The breadth of his work is catalogued in about two hundred patents in electrical, mechanical, chemical and electrochemical, and welding fields, and for instruments. During World War II, Dr. Chubb contributed to the Manhattan project.

The John Fritz Medal is an honor awarded by the following founder engineering societies: the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and American Institute of Electrical Engineers.

The award was established in 1902 in memory of John Fritz of Bethlehem, Pa., a pioneer in the iron and steel industry, and is conferred not more often than once annually for notable scientific or industrial achievement, without restriction on account of nationality or sex.

"Catalog Briefs"

IN this issue, begining on page 35 through to page 58 of the advertising section, are listed 227 items about the latest available catalogs, bulletins, and literature covering engineering equipment, materials, supplies, and services. Use the coupon on page 37 to make a selection.

Modifications Approved to Safety Code for Elevators

AT a meeting on June 12, 1946, of the Sectional Committee on a Safety Code for Elevators, A17, the following modification to Rules 124f, 124h, 124w, 121c, and 121d of the Safety Code for Elevators, to become effective Nov., 1947, was unanimously approved by the Committee.

Rule 124f: The hoistway doors or gates of freight elevators shall be provided with hoistway door or gate interlocks or with mechanical locks and hoistway door or gate electric contacts conforming to rules 121 and 122, respectively, or with mechanical locks subject to the following:

(1) Hoistway doors and gates of power elevators shall be provided with hoistway door interlocks except:

(a) Hoistway gates or vertical biparting counterbalanced hoistway doors, not power opened, or automatic and continuous pressure operation elevators having a travel of 15 ft or less may be provided with mechanical locks and hoistway door electric contacts.

(b) A hoistway gate or vertical biparting counterbalanced door, not power-opened, at a reverse or adjacent opening of an automatic and continuous-pressure-operation elevator which is not more than 4 ft above the bottom landing or, when the rise of the elevator does not exceed 15 ft is not more than 4 ft below the top landing may be provided with mechanical locks and hoistway-door electric contacts.

(c) Full-automatic and semiautomatic hoistway doors or gates, where permitted, shall be provided with mechanical locks subject to the following: (*1*) Full automatic doors or gates shall have automatic mechanical locks, operated by the car, whose function is to lock the door or gate after it has closed and prevent its reopening from the landing side (except as provided in 124m) except when the lock is released by the car as it approaches the landing. (2) Semiautomatic doors or gates shall be provided with mechanical locks whose function is to automatically lock the door or gate, after it is closed and prevent its reopening from the landing side unless the car is within the landing zone (except as provided in 124m).

(2) Hoistway doors and gates of hand elevators shall have mechanical locks which lock automatically when the car leaves the landing.

(3) In addition to the locking devices specified in 1(a) or 1(b) of this Rule, hydraulic elevators, the hoistway doors of which are equipped with interlocks or electric contacts, shall be provided with a device which will compensate for the creeping of the car away from the landing.

(4) Mechanical locks on hoistway doors or gates provided with hoistway door or gate electric contacts (not interlocks) shall have the lock so arranged as to insure the door or gate being in a position to be locked when or before the electric contact is closed.

(5) Hoistway door or gate interlocks, electric contacts, and mechanical locks shall be so located as normally to be inaccessible from the landing side of the hoistway when the door or gate is in the closed position.

124th Revise to read: Semi- and full-automatic hoistway gates will be permitted on power elevators operated from the car only. In addition, the installation of full-automatic gates shall be subject to the following restrictions:

(1) They may be installed only at terminal landings of power elevators operating at a speed not in excess of 75 ft per minute, and,

(2) They may be installed at other than terminal landings of power elevators having a speed not exceeding 75 ft per minute used primarily for carrying automobiles.

124w Revise to read: Where vertical biparting counterbalanced hoistway doors are used, hoistway door interlocks, electric contacts, and mechanical locks shall be so designed and installed that under normal operating conditions they will:

(1) Prevent the opening of both the top and bottom door panel from the hoistway or landing side when the interlock or mechanical lock is in the locked position, and,

(2) Prevent the closing of the hoistway door interlock or electric contact unless the door is in the closed position.

121c and 121d Add exception to read: Except in the case of vertical bi-parting counterbalanced doors, the door shall be considered in the closed position when the upper and lower door panels are within 2 in. of contact with each other, provided the doors are equipped with an astragal which closes the opening between the door panels when the panels are within 2 in., or less, of contact with each other.

A.S.M.E. Members Speak at Princeton Conference

D. ROBERT YARNALL, president A.S.M.E., Harvey N. Davis, past-president and fellow A.S.M.E., Alexander G. Christie, past-president and honorary member A.S.M.E., and many other A.S.M.E. members participated in the Conference on Engineering and Human Affairs held at Princeton University, Oct. 2–4, 1946. The conference was one of several being held in celebration of the bicentennial year of Princeton University.

President Yarnall spoke at the session on "The Individual Engineer." Dr. Davis participated in the discussion on "Research in Engineering." Professor Christie spoke on "Progress in the Transformation of Energy."

C. E. Davies, secretary A.S.M.E., presented a paper on "The Engineering Profession." Mr. Davis discussed the organization of the engineering profession and examined the manner in which the responsibilities of the engineering profession were being carried out. He also described various factors in the nation which were exerting a unifying influence on the profession.

Among other members who attended the conference were: Allen R. Cullimore, president, Newark College of Engineering, Newark, N. J.; Wallace Clark, partner, Wallace Clark and Company, New York, N. Y.; J. C. Hunsaker, professor, Massachusetts Institute of Technology, Cambridge, Mass.; and John A. Goff, dean, Towne Scientific School, University of Pennsylvania, Philadelphia, Pa.

E.J.C. Nominated to American Advisory Commission to UNESCO

THE Engineers Joint Council was nominated to one of the ten remaining seats on the National Commission for Educational, Scientific, and Cultural Co-operation at the first meeting of the Commission held in Washington, D. C., Sept. 23 to 26, 1946. The nomination gave recognition to the part engineers play in the cultural life of the United States.

Although encouraged by the Department of State to participate in the work of the Commission, the E.J.C. was omitted from the list of fifty nongovernment organizations chosen to send representatives to the first meeting of the Commission.

The National Commission is the first American group of nongovernmental organizations set up by the Department of State to serve as a direct and permanent link between United States citizens and the American delegation to an international body. The international body concerned is UNESCO (United Nations Educational, Scientific and Cultural Organization) which was organized in London last fall in order to help people of the world to know more about each other. The first meeting of UNESCO will be held in Paris in November, 1946.

The National Commission is composed of 100 individuals, 60 of whom represent nongovernment organizations, national in scope, such as societies, associations, and councils in the fields of education, science, radio, arts, civic life, and the press, 25 of whom represent various federal, state, and local authorities, and 15 of whom represent the nation at large.

In making public the original list, Assistant Secretary of State William Benton said:

"The formation of the National Commission is an important and distinctive event in the intellectual and social life of America. It brings together in a single body representatives of education, the press, radio, the films, science, learning, arts, and civic life, and establishes a novel procedure in co-operation between nongovernment organizations and the government.

Among the organizations named to the Commission there are: the General Federation of Women's Clubs, Federal Council of Churches in Christ in America, Congress of Industrial Organization, National Research Council, National Academy of Science, and the American Society for Engineering Education.

Although pure science is represented by several organizations, it is believed that the election of the E.J.C. will improve the Commission by giving engineers, who represent applied science, a voice in its deliberations.

The next meeting of the National Commission will be held in February, 1947. The organizations elected to the ten remaining seats on the Commission will be announced at that time.

New Developments in Nuclear Physics Discussed at Joint A.P.S. and A.S.M.E. Meeting

New Elementary Particles Discovered

PHYSICISTS filled the auditorium, crowded the lobbies, and gathered in groups before the Engineering Societies Building, New York, N. Y., during the joint meeting of the Metropolitan Sections of the American Physical Society and The American Society of Mechanical Engineers, Sept. 19 to 21, 1946. They came to hear renowned physicists from many countries of the world discuss fundamental developments in the field of nuclear science.

The meeting was planned by the American Physical Society to take advantage of the presence in the United States of many eminent physicists who came here to participate in the Princeton University Bicentennial Conference on the Future of Nuclear Science on Sept. 23 to 25, 1946. The auditorium of the Engineering Societies Building was made available for purposes of the meeting by The American Society of Mechanical Engineers as a courtesy to a sister society whose contributions to science form the basis of mechanical engineering.

During the three-day meeting 48 papers dealing with studies of the upper atmosphere, cosmic rays, subnucleonic physics, and the design of the latest atom-smashing machines were discussed.

"Now that we understand and have applied the principles of transforming the nucleus of the atom into protons and neutrons, it becomes the task of science to explore the protons and neutrons themselves," said Dr. John A. Wheeler, associate professor of physics, Princeton University, who arranged the program of the meeting.

Mesons Defined

"Cosmic rays bombarding the upper atmosphere are constantly breaking up protons and neutrons, much as we artificially break up the nucleus of the atom by controlled fission. The bombardment releases new particles called mesons (pronounced mees-ons), about which little is known.

"Study of this new subnuclear frontier may conceivably lead to observation of complete conversion of matter to energy.

"Discovery how to release the untapped power in those elementary particles on a reasonable scale might completely alter our economy and the basis of our military security."

Research on this frontier made little progress during the war because all available talent was devoted to application of nuclear physics in development of the atomic bomb, according to Dr. Wheeler.

"Other nations have not neglected this work during the war," he said. "We must resume it vigorously."

Mesons are known to have a mass of about 200 times the mass of the electron, or one ninth the mass of a proton, Dr. Bruno Rossi, physicist, Massachusetts Institute of Technology, said in a review of present knowledge of cosmic-ray mesons and an outline of investigations yet to be made.

They are also known to be so unstable that the average life is only 2 millionths of a second. Mesons are not part of the primary cosmic radiation, he said, but are produced in the atmosphere, directly or indirectly, by primary rays which are for the most part positively charged.

V-2 Rockets Aid Studies

Great interest was centered in the report of studies made by Dr. J. A. Van Allen, Dr. H. E. Tatel, and Dr. R. P. Petersen, of the Applied Physics Laboratory, Johns Hopkins University, Baltimore, Md. Their studies, carried on with the aid of German V-2 rockets fired to a height of 100 miles, disclosed a concentrated belt of cosmic rays at an altitude of 100,000 ft. Cosmic-ray particles have energies millions of times greater than the energy released by nuclear fission.

Twenty-five German V-2 rockets have been constructed from captured parts by engineers of the Army Ordnance Department and the General Electric Company. While the launching and collecting of flight data have been under the supervision of Army Ordnance Department, various research centers have co-operated in these studies. Each group has been assigned four or five rockets.

In a report by Dr. L. LePrince-Ringuet of the Laboratoire de L'Ecole Polytechnique, Paris, France, the probable existence of a new particle in cosmic radiation with a mass about five times that of the meson or 1000 times the mass of the electron, was discussed.

The existence of two new subnucleonic particles neither of which has any mass, and which move with the velocity of light, was reported by Prof. E. P. Wigner of the Clinton Laboratories, Oak Ridge, Tenn. He said that one of these massless particles may be considered analogous to transverse sound waves and the other to longitudinal sound waves.

Atomic Power Versus Steam

A newspaper reporter at the meeting, searching desperately for the practical significance of the discussions, asked Dr. G. B. Pegram, member A.S.M.E., member A.S.M.E. Committee on Nuclear Energy Application, and professor of physics, Columbia University, how nuclear physics would affect the American power industry. According to Dr. Pegram, atomic power will not upset the economy of steam or hydraulic power utilities but would provide a highly useful supplementary source of power in localities where neither steam nor hydraulic power is available or practicable.

New designs of nuclear accelerators now under construction in various laboratories of the United States were discussed during the Saturday morning session, Sept. 21. Prof. Luis W. Alvarez, University of California, described a proton linear accelerator which is capable of developing a million volts for each foot of its length and which can conceivably be built to the length of one mile. Dr. H. R. Crane, University of Michigan, described a new type of synthroton now under construction called the "race track" because its electron orbit has the form of an oval race track.

With the completion of these powerful laboratory tools it is expected that American scientists will be able to add considerably to our present knowledge of the atom.

Actions of the A.S.M.E. Executive Committee

At a Meeting Held in Boston, Mass., Sept. 30, 1946

A meeting of the Executive Committee of the Council was held at the Hotel Statler, Boston, Mass., Sept. 30, 1946. There were present: D. Robert Yarnall, chairman, R. F. Gagg, A. C. Chick, J. Noble Landis, E. J. Kates, and J. E. Lovely of the Council; A. R. Mumford (Sections); K. W. Jappe, treasurer; Eugene W. O'Brien, president-elect, F. S. Blackall, Jr., director-elect; R. A. North, chairman, and P. W. Thompson, member, Committee on Meetings and Program; Ernest Hartford, executive assistant secretary; and C. E. Davies, secretary.

Actions of Finance Committee

Approval by the Finance Committee of the following actions taken by the Council was noted: (1) Publication by the Society of the Metal Cutting Data Sheets; (2) support by the Society of a preliminary informatory program about the Engineers Joint Council; (3) support by the Society of publication of a descriptive booklet on Engineers Council for Professional Development; (4) employment of additional staff to serve the Standing Committee on Research in development of new research projects; and (5) establishment of a custodian fund for welded stay construction.

Appointment of Alton C. Chick

It was noted that the Council approved by letter-ballot the appointment of Alton C. Chick to the vacancy on the Executive Committee caused by the death of Alexander R. Stevenson, Jr.

Nominations for Vice-President Region III

Following a review of the results of a canvass conducted by the secretary of Region III among the Sections of that Region for the purpose of suggesting a list of names to the Council from which a vice-president could be appointed to fill the unexpired term of the late Alexander R. Stevenson, Jr., it was voted to request the secretary of Region III to submit the suggested list and biographical and committee service information to the Sections of

Region III for an expression of their choice of nominees and to authorize the secretary of the Society to transmit the results of this ballot to the Council for final selection of a member to serve on the Council as vice-president of Region III until December, 1947.

1947 Annual Meeting

Following discussion of a report submitted by the Committee on Meetings and Program which reviewed the congestion and hotel problems involved in planning an annual meeting in New York, N. Y., it was voted to make no changes in the plans for the 1946 Annual Meeting, but to request the Committee on Meetings and Program to explore the possibilities of holding the 1947 Annual Meeting in Atlantic City, N. J.

Student Copies of Mechanical Engineering

Upon recommendation of the Committee on Publication the following temporary measures with regard to student copies of MECHANICAL ENGINEERING were authorized to conserve paper supply: (1) To print student copies only for paid-up student membership at the time of going to press; (2) to discontinue practice of providing back issues of MECHANICAL ENGINEERING to students who sign up late; and (3) to terminate student copies each year with the May issue.

Honors and Awards

Upon recommendation of the Board of Honors and Awards, the following awards were approved:

Charles T. Main Award to Victor S. Rykwalder, University of Detroit, for his paper, "Creative Engineering as a Factor in Promoting Full Employment."

Undergraduate Student Award to Paul A. Thompson, Illinois Institute of Technology, for his paper, "Synthetic Sapphire—A New Industrial Engineering Material."

Change in Section Name

Upon request of the Des Moines Section, approval was voted for a change in name to the Central Iowa Section.

Local Engineering Councils

The Committee noted a letter from P. T. Onderdonk, member A.S.M.E., of the Committee on Organization of Engineering Profession, in which he commented on the future trend of local engineering councils. Mr. Onderdonk called attention to the rapid spread of the organization of such councils and expressed the opinion that if the local councils can limit their undertakings to problems of common interest among engineers in those fields where action by a single organization is ineffective, their success may lead to councils on the state or regional and, later on, the national level.

Engineering Education

The secretary was authorized to proceed with plans for a conference of representatives of other organizations in the mechanical-engineering field to be held after the 1946 Annual Meeting for the purpose of reviewing the relationship of the various specialties in mechanical engineering to the general scheme of engineering education and particularly the curricula in mechanical engineering.

Talk About A.S.M.E.

Following review of a manuscript which had been written as a suggested talk, which, when accompanied by a film strip, could be used by Society officers as an aid in describing activities of the Society to the Sections and Student Branches, the secretary was authorized to proceed with the preparation of the film strip and the purchase of projection equipment so that the talk could be used at the 1946 Annual Meeting.

Certificates of Award

Upon recommendation of E. E. Williams, vice-president, A.S.M.E. Region IV, certificates of award were approved for the following retiring chairman: D. H. Guldberg, Birmingham Section; L. G. Haller, East Tennessee Section; S. L. Stewart, Florida Section; T. O. Sills, Piedmont-North Carolina Section; E. S. Theiss, Raleigh Section; and Arthur Roberts, Jr., Virginia Section.

Appreciation

The Committee noted with pleasure a communication sent to the chairman of the Committee on Dues-Exempt Members' Contribution by Jack F. Schmidt, a recipient of the Ellison Scholarship awarded by that Committee, which expressed appreciation and said "this scholarship was one of the factors that enabled me to stay in school until I graduated last October."

Atomic Energy Commission

Following consideration of a request of A. C. Klein and W. F. Ryan, Stone and Webster Engineering Corporation, Boston, Mass., that the Society urge the appointment of an engineer on the Atomic Energy Commission, it was voted to authorize President Yarnall to write to President Truman urging that an engineer be appointed to the Commission.

Interchange of Membership

Approval was voted for an interchange of membership between the secretary of the A.S.M.E. and the president of the American Management Association.

Appointment

The appointment of Albert C. Weigel as honorary vice-president to represent the Society at the Conference of "Fuel and the Future" in London, was approved.

Sections

Virginia Section Hears J. I. Yellott Discuss Coal-Burning Gas-Turbine Locomotive

MORE than 100 members and guests of the A.S.M.E. Virginia Section heard John I. Yellott, member A.S.M.E., director of research, Locomotive Development Committee, describe the coal-burning gas-turbine locomotive now being developed under his direction. The meeting was held at the Hotel Roanoke, Roanoke, Va., Sept. 13, 1946.

SPEAKERS AT THE VIRGINIA SECTION MEETING AT HOTEL ROANOKE, ROANOKE, VA., SEPT. 13, 1946

(*Left to right:* E. E. Williams, vice-president, A.S.M.E. Region IV; Ralph G. Henley, general superintendent motive power, Norfolk and Western Railway Company; Dr. John I. Yellott, member A.S.M.E., director of research, Locomotive Development Committee; C. E. Pound, vice-chairman, A.S.M.E. Virginia Section; and H. R. Hopkins, chairman, A.S.M.E. Virginia Section.)

Dr. Yellott reviewed carefully with the use of slides, the resources of petroleum, natural gas, and coal in the United States. He said that petroleum deposits now known to exist would probably last 15 years, that 32 years' worth of natural gas are still left in the earth, but that known coal deposits would last the world 3000 years.

"Because of the tremendous amount of coal still in the earth, any long-range planning of engines run by coal as fuel will be worth while," Dr. Yellott said. "Yet, in the face of this fact, there is not a single coal-burning locomotive now on order in any of the major locomotive-manufacturers' plants. Furthermore, all switchers are Diesel because of the low efficiency rating of coal-burning steam engines."

Prior to Dr. Yellott's address, E. E. Williams, vice-president, A.S.M.E., Region IV, spoke briefly. He was followed by W. M. Sheehan, chairman, A.S.M.E. Committee on Membership Development, who explained the purposes of the A.S.M.E. and the advantages of Society membership.

H. R. Hopkins, chairman, A.S.M.E. Virginia Section, presided and introduced R. G. Henley, general superintendent motive power, Norfolk and Western Railway Company, who in turn introduced the main speaker of the evening.

Central Illinois Section Meets With S.A.E.

The meeting on Sept. 30 was held at the Jefferson Hotel, Peoria, Ill. Paul Huber, assistant director, General Motors Proving Ground, gave a talk entitled, "Testing at General Motors Proving Ground," illustrated with pictures. This first fall meeting was held jointly with the Peoria Chapter of the S.A.E. One hundred and fifteen were present.

Cincinnati Section Holds Annual Ladies'-Night Dinner

The annual ladies'-night dinner was held on Sept. 12 in the Schneider Memorial, Engineering Societies Building, Cincinnati, Ohio. Paul L. Heath, better homes supervisor, Westinghouse Electric Corporation, gave a talk on "Electrical Living—The Home of Tomorrow." The speaker said that while some developments which were described are admittedly still in the engineering stage, every future home should include adequate power circuits. Plans for four types of homes: thrift, budget, ideal, and de luxe, were discussed in detail. A technicolor movie, "The Dawn of Better Living," and slides illustrated the talk. A question and answer period followed. Seventy-one attended the dinner, and 100 were in the audience to hear the speaker.

Colorado Section Hears of Rocket Developments

At the Sept. 27 meeting in the Chamber of Commerce, Denver, Colo., Dr. G. F. Green of the General Electric Company gave an interesting description of the rocket developments at White Sands, New Mexico, illustrated by slides and movies; also movies of German developments were shown. Practical peacetime uses and applications of rockets were described, as well as their military value; also, the high energy rates and velocities developed were vividly depicted.

Dayton Section Meets With Dayton Technical Society

A joint meeting with the Dayton Technical Society was held on Sept. 16 in the Engineers Club of Dayton, Ohio. Walter J. Murphy, editor, American Chemical Society, gave a talk entitled, "Impressions of Operation Crossroads." The speaker, an official observer at Operation Crossroads, described the experiences of the press group on the first test. Claiming membership in "The League of Frightened Men," Mr. Murphy emphasized the need for correction of public opinion based on first press reports of failure of the "A" bomb to meet expectations. Color and black-and-white slides of both the trip and bomb tests were shown. An audience of 375 heard the talk.

Fort Wayne Section Holds Season's First Meeting

The first meeting of the season was held on Sept. 5. It was in part devoted to making plans for the coming year, and then followed a stag-style affair with sound movies and refreshments. Ira Terry, member A.S.M.E., works engineer of the Fort Wayne Works, General Electric Company, gave an impromptu talk. A motion picture followed, depicting the construction of the Golden Gate bridge. Twenty were in attendance.

Two September Meetings Held by Ithaca Section

"Future Trends in Aviation" was the subject discussed by Dr. C. C. Furnas, Cornell Aeronautical Laboratories, Buffalo, N. Y., at the Sept. 23 meeting in the Arlington Hotel, Binghamton, N. Y. Dr. Furnas outlined the possibilities of atomic energy as a power source for uninhabited aircraft, and predicted great steps in commercial, private, and military air development within the next 5 years. He explained the facilities now maintained at the $4,000,000 laboratory which was subsidized by six other nationally known aircraft companies in the interest of aeronautical research.

On Sept. 26 a meeting was held in the Langwell Hotel, Elmira, N. Y. The speaker, Harry Kough, sales manager, Eutectic Welding Alloys Company, gave a talk entitled "Eutectic Low-Temperature Welding." After an elaborate demonstration of eutectic bonding alloys at the American LaFrance Foamite Corporation, in the afternoon, Mr. Kough described the advantages realized by the use of eutectic alloys such as minimum metal distortion and fracture, and ability to bond cast iron, zinc-base castings, aluminum, etc. Numerous slides were shown to illustrate unusual applications. Thirty-nine enjoyed the talk. After the program, section officers were elected at the committee meeting.

Lehigh Valley Section Hears Talk on "Air Conditioning"

A meeting was held on Sept. 27 in the Berwick Hotel, Berwick, Pa. Charles Leopold gave a talk on "Air Conditioning," which was enjoyed by the audience of 75 members and guests. Mr. Leopold explained the "comfort chart" and the air velocities and per cent of relative humidity necessary for reasonable comfort in an air-conditioned room. He also described a large project which his company had installed similar to that in the Pentagon Building, Washington, D. C. A question and answer period followed the talk.

"Control of Process Dusts" Talk at Mid-Continent Section

The first meeting of the season was held on Sept. 19 in the Ivory Room, Mayo Hotel, Tulsa, Okla., with W. Fred Stewart, chairman, presiding. The program was a talk entitled "The Control of Process Dusts in Manufacturing," by John Kane, American Air Filter Company, Louisville, Ky. Mr. Kane introduced himself as a specialist who covers only a tiny fraction of the field of mechanical engineering. He then demonstrated how extensive and involved this small item of dust control might become; compared a dust-collecting unit to a petroleum pipe line gathering system, with problems similar in nature, if not in degree; and explained methods of control of systems with multiple gathering points, emphasizing the fact that the chief problem was to pick up the dust at the point of origin before it could scatter over any considerable area. Most systems, he said, are designed with a factor of safety of about 100, so that they will stand considerable abuse and alteration without seriously impairing their performance. Using slides, he explained differences in design required by the nature of the application, and illustrated his point most forcibly by contrasting a unit for a foundry shakeout for bench flasks with another to handle flasks weighing 50 tons or more, handled by huge overhead cranes. Thirty-eight members and guests were in the audience.

North Texas Section Resumes Meetings

The opening meeting was held on Oct. 1. C. H. Schumaker, chairman presided and led a discussion of "National Employ the Physically Handicapped Week." Victor H. Schoffelmayer, agricultural science editor of the Dallas News, presented a thought-provoking lecture entitled "Texas' Industrial Growth." The speaker pointed out that the continued growth of industry in this predominantly agricultural region could be made possible only by the processing of agricultural waste products. Such an industrial expansion would provide an ideal culture whereby industry would have an

ever-replenished supply of raw material and industrial workers would prosper. Agriculture would have new markets for raw material, and the lot of the agriculturist would be vastly improved. Eighteen members and four guests were present.

Wilmington, Del., Sub-Section Holds First Meeting

The inaugural session of the Wilmington, Del., Sub-Section was held at the Hob Tea Room on Sept. 25, 1946. The speaker was R. M. Dunn, superintendent of engineering and maintenance, Trans-World Airlines International Division. Mr. Dunn outlined the work involved from the time specifications for an aircraft are issued to a manufacturer, through design, construction, air-line and government test, plus the constant vigilance required to keep planes air-borne. He also spoke of the work that is under way equipping and testing planes to assure safety during take-off and landing when visibility is poor.

H. D. Harkins, chairman of the organizing committee, presided and introduced the officers for the first year. They are: F. H. McBerty, chairman; Walter Locke, vice-chairman; and A. P. Wendland, secretary-treasurer. The meeting was attended by 85 members and guests.

"The Right and Wrong in Time Study" Topic at Worcester Section

At the Sept. 26 meeting in Worcester Polytechnic Institute, Worcester, Mass., Prof. Warren L. Ganong, northeastern and industrial consultant, spoke on "The Right and Wrong in Time Study." In his talk Professor Ganong re-examined the purposes and functions of time study as related to motion study; criticized current time-study practices and techniques; and offered some concrete recommendations that most managements could apply directly to increase the effectiveness of the time-study department. He also emphasized the impact of time study on labor relations. Some of the high lights of the talk were illustrated by motion pictures from the speaker's personal library of films. One hundred and twenty-five were present.

Youngstown Section to Reorganize

S. R. Beitler, vice-president Region V, A.S.M.E., was the guest and speaker at the dinner meeting held on Sept. 18 at the Dinner Bell, Youngstown, Ohio. Since the purpose of the meeting was for reorganization of the Section, Mr. Beitler talked of the work of the various sections, stressing the fact that an earnest effort should be made to obtain new members. He said that the value received from a membership in the A.S.M.E. cannot be measured in actual dollars and cents.

It was voted to continue the past executive committee in office until July, 1947. Two vacancies on the committee were filled by the election of P. R. Duffey as committeeman and John G. Schaefer as secretary and treasurer.

Frank J. Bowers, chairman of the program committee, asked for a discussion on the type of meetings the membership desired. He also asked for suggestions as to topics for speakers. C. E. McCormick proposed that a copy of the new membership list be sent to each member, to create fellowship and interest.

Student Branches

University of California Branch

Vice-chairman Albert Strong opened the Sept. 25 meeting in room 104, Engineering Building, and introduced Dr. Moyer of the physics department of the University. Dr. Moyer showed slides taken of the atomic-bomb explosions in New Mexico and a moving picture taken of the atomic-bomb explosion over Nagasaki, from the tail-gunner's position in the ship that dealt the fatal blow. Dean M. P. O'Brien, dean of the college of engineering, gave a short welcoming talk to the new students and then told of his experience on Bikini and in "Operation Baker." Prof. J. W. Johnson closed the meeting with a film and accompanying remarks on some of the model analyses on experiments for "Operation Baker." Professor Johnson's films were taken at the David Taylor model basin, Washington, D. C., and at the U. S. Navy Mine Warfare test station at Solomons, Md.

University of Cincinnati Branch

The first meeting of the coming school year was held on Sept. 26 in Student Union. The subject of presenting papers to the local chapter of the A.S.M.E. was thoroughly discussed. J. Kimeny outlined a program whereby members of the branch would receive lectures on the methods of preparing a paper, and hints on how to present a technical paper to a group. Prof. R. L. Smith, member A.S.M.E., advise

Union Pacific Photo

STUDENT BRANCH OF THE UNIVERSITY OF NEBRASKA INSPECTING NEWLY REPLATED DINING-CAR SERVICE AT THE UNION PACIFIC RAILROAD SHOPS AT LINCOLN, NEB.

to the branch, gave a short talk, welcoming new members and outlining the aim and purpose of the A.S.M.E. The branch accepted the invitation of the local chapter to attend a lecture on gears on Oct. 10.

University of Colorado Branch

The officers of the branch for the year 1946–1947 are: Ken Marquand, student chairman; Frank Squier, vice-chairman; Betty Beck, secretary; Richard Johnston, treasurer; W. L. King, publicity chairman. They were elected at the final meeting of the branch last spring.

Marquette University Branch

On Aug. 8 in the Engineering Building, election of officers for the following quarter resulted as follows: William Pautke, president; Marvin Heda, vice-president; Howard Nuerenburg, secretary; Leslie Randall, treasurer. Prof. John E. Schoen was unanimously reelected honorary chairman. Edward Jerger, president for the summer quarter, who presided, led a brief discussion on the activities of the past quarter, and on the advisability and advantage of becoming a junior member of the A.S.M.E.

University of Nebraska Branch

The branch recently spent a day in Omaha to inspect the shops of the Union Pacific Railroad Company, the Farm Crops Processing Corporation, and the Nebraska Power Plant. On the first visit of the day, to the Union Pacific Railroad Company's shops, the party was fortunate in being present just at the time when one of the huge generating plants was being maneuvered into place on its carriage. The group inspected the machine shop, forge shop, carpentry shops, and the upholstering shops; also observed various heat-treating and welding methods. At noon the Omaha Engineers' Club was host at a luncheon served in the Chamber of Commerce building. The guest speaker was E. Brown, vice-president, Allis-Chalmers Company, who spoke on the past, present, and future of turbines. The second trip, through the Farm Crops Processing Corporation, gave the students an insight into the production of corn syrup and the products of potatoes which were at that time being processed. The third visit was to the Nebraska Power plant. The tour included the coal-storage facilities, the boiler rooms, the water-cleaning system, control system, and the turbines. Accompanying the group of forty were N. H. Barnard, member A.S.M.E., honorary chairman, and J. K. Ludwickson, member A.S.M.E., both of the University of Nebraska. Acting as host and guide was J. W. Kurtz, member A.S.M.E., also of the University.

Purdue University Branch

On Sept. 26 in the Mechanical Engineering Building the branch met for the first meeting of the Fall term. After the new officers were introduced, F. Jehle, past-chairman of the Central Indiana Section and an outstanding industrialist, gave a survey of the A.S.M.E. activities in industry. Dr. G. A. Hawkins, of the mechanical engineering research department, spoke on "A.S.M.E. in Research." He was followed by Dr. H. A. Bolz, head of the general-engineering department, who told of "The Role of the A.S.M.E. in Education." A total of 125 students joined at the close of the meeting.

University of Southern California Branch

The first meeting of the new semester was held on Sept. 26 in the Administration Building. Henry Hoste, chairman, presided. Membership applications and renewals were accepted, and Prof. E. K. Springer, honorary chairman, discussed the regional student meeting. The guest speaker was J. C. Brown, regional vice-president A.S.M.E., who described the Society's organization. Plans were outlined for future meetings.

Texas A.&M. College Branch

The opening meeting of the Fall term was held on Oct. 1 in the Mechanical Engineering Building. The following officers were elected: R. F. Eisenhauer, chairman; M. A. Horton, vice-chairman; W. B. McDaniel, secretary; P. W. Marks, treasurer; and C. Y. Hendricks, reporter. M. A. Horton will also act as head of the program committee. An extensive drive for new members will commence immediately, with W. J. Graff as chairman of the membership committee. Carl Files, junior member A.S.M.E., honorary chairman, gave a short talk on the advantages of A.S.M.E. membership.

Harvard University Reorganizes Engineering Curriculum

IN the belief that the time of an engineering student at a university is best occupied in the mastery of theory and that his early years in industry are best devoted to learning first-hand technical details and current engineering practice, Harvard University has reorganized the curriculum of undergraduate and graduate studies to meet the new concept of engineering education.

Classification of students as mechanical, electrical, or civil, has been discontinued and a new department of engineering sciences and applied physics has been organized under the chairmanship of Prof. F. V. Hunt, which will give undergraduate courses in Harvard College. Professional courses on the graduate level will be taught in The Graduate School of Engineering, under the direction of Dean Gordon M. Fair.

The undergraduate program set up by the new department lays emphasis on mastery of fundamental mathematics, physics, thermodynamics, and metallurgy. In the senior year the student will be free to elect a few specialized courses.

On the graduate level courses deal with selected portions of those fields that find application in current engineering practice. Because of the sound grounding in basic principles provided by the undergraduate program, it is believed that the material of these courses can be presented effectively and expeditiously.

Undergraduate courses will lead, as heretofore, to the bachelor's degree, A.B. or S.B., and graduate study in the new department may be directed toward the degrees A.M. or S.M. after one year of graduate work, to the degree M.Eng.Sci. (Master of Engineering Science) after two years of graduate work, or to the degree Ph.D. upon the completion of a suitable research project.

Pamphlets describing the courses and facilities available in the new department may be had upon request to Prof. F. V. Hunt, Cruft Laboratory, Cambridge 38, Mass., and the offerings of the Graduate School of Engineering, upon request to Dean Gordon M. Fair, Pierce Hall, Cambridge 38, Mass.

A.S.M.E. Sections

Coming Meetings

Chicago. November 7. B/G Restaurant, 432 North Michigan Ave., Chicago, Ill. The Junior Division of the Chicago Section inaugurates a series of eight meetings. Subject: "An Engineer's Observations of Engineering Practices in Soviet Russia," by L. G. Bertenshaw, General American Transportation Company.

November 22. Carson Pirie Scott and Com-

STUDENT BRANCH OF PURDUE UNIVERSITY SIGNS UP NEW MEMBERS

pany, North Bay Room. The Women's Auxiliary is giving a Book Review Tea at which Mrs. Virginia Kendall Upham will present a review of the well known novel "The King's General."

Detroit. November 6. Joint Meetings with The Engineering Institute of Canada, Prince Edward Hotel, Windsor, Can.

Hartford. November 19. Hartford City Club. Subject: "Personal Flying," by W. T. Piper, Piper Aircraft Corporation, Lock Haven, Pa.

Philadelphia. November 14. Stacey Trent Hotel, Trenton, N. J. Subject: "Personal Flying—Light Planes and Airports," by W. T. Piper, Piper Aircraft Corporation, Lock Haven, Pa.

November 19. Frankford Arsenal Gage Laboratory. "Precision Instruments." There will be a demonstration of the latest devices.

November 26. Philadelphia Engineers Club. "Coal-Burning Gas Turbine," by J. I. Yellott, Locomotive Development Committee.

Milwaukee. November 12. Meeting to be held in Michigan City, Ind. Phil Sprague is in charge of this meeting.

Southern California. November 5. Rodger Young Auditorium at 6:30 p.m. (Subject to be announced.)

November 14. Management Meeting and Field Trip to C. F. Braun Co. at 6:30 p.m. C. F. Braun, president of the C. F. Braun Company, will present a very interesting subject.

November 21. Instrument Division—Rodger Young Auditorium at 6:30 p.m. Subject: "Radar as an Instrument," by R. C. Main, Robertshaw-Grayson Company.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	212 West Wacker Drive	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

GRADUATE MECHANICAL ENGINEER, fourteen years' plant-engineering and supervisory experience. Outstanding record. Diversified background, having designed and built plants, installed machines, responsible for all plant maintenance. Age 38, Married. Me-102.

MECHANICAL ENGINEER, B.M.E. Cooper Union, 1943. Six months' experience design, development, and production of semiautomatic machinery. Electronics training, Navy. Taking masters E.E. course at night. New York area desired. Me-103.

ADMINISTRATIVE ENGINEER, now employed in design and construction by one of the largest chemical companies. Twenty years' experience steam, chemical-plant problems. Me-104.

GRADUATE MECHANICAL ENGINEER. Age 32, fully experienced in plant engineering, design, research and development, assembly and process improvements. Held positions as chief engineer. Possesses executive ability. Prefers New York location. Me-105.

SALES ENGINEER, experienced in mechanical and electrical selling also industrial engineering experience. Chemical-engineering degree. Salary and commission or bonus. Location, New York, N. Y. Willing travel. Me-106.

MECHANICAL ENGINEER, graduate B.S., 20 years' experience boilers, turbines, engines, Diesels, generators, storage batteries. Desires position as sales engineer. Available November 1. Me-107.

MECHANICAL ENGINEER, EXECUTIVE, 25 years' experience and successful record design, development, and production gas-pressure control equipment or steam specialties with supervision of construction or plant operation. Available as chief or project engineer. Location preferred, Buffalo or Niagara frontier. Me-108.

ENGINEER, age 41, B.S. in E.E., 1928, single, broad experience metal stampings, heavy machinery design, tool and product design, patent specifications. At present chief engineer in small plant; desires general-manager position in medium-sized plant or chief engineer in large plant. Me-109.

FUEL AND POWER ENGINEER, 30, M.S. degree, 4 years' experience in steam power-plant operation and combustion engineering. 5 years as Army Engineer officer. Desires position in power-plant operation in Southeast. Me-110.

STEAM POWER PLANT SUPERINTENDENT, First-class Quebec license, age 39, diversified experience in operation, maintenance, and supervision of oil, pulverized-fuel, and stoker-fired boilers with turboelectric units. Desires position as steam plant superintendent or equivalent, preferably pulp and paper mill in Ontario or Quebec. Available on reasonable notice. Me-111.

PLANT ENGINEER OR MASTER MECHANIC, 35, married, no children. Experienced mining, milling, marine machinery, and all metal trades, general maintenance and repair work, also new construction. Available October 1. Me-112.

MECHANICAL GRADUATE, 26, Newark College of Engineering. Three years' toolmaking experience building and developing tools, dies, gages. Two years naval ordnance officer. Desire connections in metropolitan New Jersey or New York. Me-113.

MECHANICAL ENGINEER, young, energetic, B.M.E., present evening studies for M.M.E.; 3 years' automatic and semiautomatic hydraulic and electromechanical machine design; 6 months' construction; seeks position greater scope, responsibility. N.Y.C., metropolitan area. Me-114.

MECHANICAL ENGINEER, B.E., registered, age 34, experienced plant engineer, draftsman, on board and supervising in layout and design. Supervised 100 employees in shop and construction trades several years. Had responsible charge as project engineer on $1,000,000 plant expansion. Desire duties in line with background or will enter allied fields of sales, development, time-study. Me-115.

GRADUATE MECHANICAL ENGINEER, 21, married. Five-month Diesel training course by Navy; naval officer on Diesel-powered vessel. Desires position in Diesel or other I.C. engine research or development. Me-116.

MECHANICAL ENGINEER, M.E. degree, diversified experience, interested in product design and development. Location, metropolitan New York or vicinity. Full particulars supplied. Me-117.

JUNIOR MECHANICAL ENGINEER, 23, B.S., 1944, Cornell. Recently discharged naval officer. Interested in manufacturing in heavy-industry plant engineering, production engineering, assistant to superintendent. Available immediately. Any location. Me-118.

SALES ENGINEER, M.E. degree, ex-A.A.F. pilot. Proved sales record. Has contacted wide range of industrial plants for major oil company. Writing experience includes editing house organ. Single, 26, personable. Me-119.

[1] All men listed hold some form of A.S.M.E. membership.

POSITIONS AVAILABLE

INDUSTRIAL ADVERTISING WRITER, not over 35, preferably with some experience civil or mechanical engineering. Salary open. Ohio. W-7813.

INDUSTRIAL ENGINEER, with experience heavy machinery and heavy industry generally, for coal production and operations. Will supervise time and operation studies in underground operation, analyzing maintenance practices, review and analyzing cost estimates and study machine-shop practices and

layouts. $4500–$6000. Virginia. W-7818.

ENGINEERS. (a) Mechanical engineers, 2, with design and layout experience for plant engineering department of drug manufacturer. (b) Maintenance and construction engineers, 2, one having had experience in construction work, but with emphasis on the mechanical side of construction; other having had experience shop engineering, supervising men in setting up and repairing chemical equipment. Approximately, $4200–$4800. Northern New Jersey. W-7837.

PROJECT ENGINEER, with broad research and development experience on servomechanisms, electronic controls, calculating mechanisms. $6000–$7000. New York, N. Y. W-7838(a).

ASSISTANT TO DIVISION ENGINEER, 35–45, mechanical or electrical graduate or equivalent with ten years' power-plant experience, to develop basic data for power-plant design and utilities distribution; check and recommend improvements in operating and maintenance procedures; prepare equipment specifications and make heat balances. Some traveling. $5200. Pa. W-7841.

MECHANICAL ENGINEER, graduate preferred, under 40, for estimating work, preferably with some experience in steam-electric stations and industrial power plants. $5000. New York, N. Y. W-7844.

OPERATIONS ENGINEERS, technically trained, with ability and training in field of co-ordinated operation of plant, for public utility. Should have thorough knowledge of system dispatching and power-plant operations, transmission of power, relaying and communication. Write giving personal and employment record. Texas. W-7846.

MECHANICAL OR CHEMICAL ENGINEER, with plant-layout and production experience, to be responsible for laying out and placing in operation plastic plant producing imitation leathers. Must be able to speak Italian. Two-months' training in U. S. $5000–$6000. Italy. W-7856.

ENGINEERS. (a) Tool designer, capable of developing own ideas on board and supervising work of assistants. Must check construction and performance. Diversified products demand wide variety of dies, jigs, fixtures, and special-purpose tools. (b) Methods-process engineer, resourceful, to develop methods and shop layouts for variety of complex assemblies. Must be able to work with other engineers in order to put ideas to work. Man with substantial experience preferred, but young man with good engineering education will be considered. Write giving personal, educational, and experience record, also salary desired. Western New York. W-7869.

ENGINEERS, 35–45. (a) Executive engineer, mechanical graduate, will be responsible for all engineering of company and must have had engineering experience in the heavy industries, preferably with some knowledge of pulp and paper manufacture. $10,000. (b) Industrial engineer with at least five years' experience in methods, planning, scheduling in heavy industry, preferably pulp and paper. $6000–$7500. New Hampshire. W-7873.

PROCESS ENGINEER, 30–45, with previous supervisory experience and well versed in tooling, processing, methods, and time and motion study, to take charge of these departmental functions. Must be thoroughly familiar with the manufacture of small semiprecision parts of electrical and mechanical nature and be capable of planning and executing a comprehensive program. Should be able to work harmoniously with other departments as well as his own. Western New York. W-7875.

PRODUCT ENGINEER, thoroughly experienced, preferably in the plumbing-fixture field, to assume complete responsibility of product design. $5000–$8000. Michigan. W-7900.

ENGINEERS. (a) Truck-engine designer (3) with eight to ten years' experience on heavy-duty design. $6000–$7500. (b) Truck engineers, test engineers, and bus engineers, transmission designer, and axle designer. $5200. (c) Torque-converter engineer, must have had at least five years' experience in automotive torque conversion. New Jersey. W-7909.

ENGINEER. (a) Project engineer, with five to ten years' electrical-mechanical and electronics experience on small-mechanism development, industrial instruments, automatic pulse. Any servo or control experience helpful. Salary open. (b) Patent attorney with technical experience in electrical-mechanical or electronic industry. $7500. (c) Designers to design instruments, as just stated. $6000–$7000. Michigan. W-7916.

FACTORY MANAGER, 40–50, with broad background in management of metal-fabrication plants employing at least 2000 people, preferably in automotive or allied industry. $15,000. Detroit area. W-7939.

ENGINEERS. (a) Process engineer, to study existing operations of mill, defining by flow charts the process steps, manpower and material losses in each step of the existing operations into one machine; to change the sequence of existing operations where necessary to give the minimum number of machines in the over-all process; to establish by models or machines the experimental elements of the revised process; to combine wherever possible the final packaging operation of the product with the last step in the manufacturing operation. (b) Process machine designer, who has had five to ten years' experience as mechanical designer on special and automatic machinery. Should be qualified through training and experience to take broad view of design problem, which will enable him to select quickly the proper elements necessary to best solution of problem. Should require minimum experimentation to determine what method or equipment is needed. Duty will be to translate plans and ideas into a working specification, clarifying the method of procedure and equipment to be used. Should have thorough knowledge of basic mechanical principles and working knowledge of large variety of commercial, mechanical, hydraulic, and electrical devices. W-7945.

MACHINE DESIGNERS (leaders), engineering degree desirable, to develop, design, and detail automatic and semiautomatic machinery, compute stresses and strains in connection with strength of materials. Three to six years' experience on design, development or detailing of automatic, semiautomatic or ordnance machinery desired. New York, N. Y., Delaware, and Connecticut. W-7963.

FACTORY SUPERINTENDENT, 35–50, for manufacturer of paper-mill wire cloth. Should be mechanically inclined, preferably technically trained, able to handle labor. After training for three months in the company will assume responsibility for production from the standpoint of quality and quantity. Salary, $4000–$6000 year, with a participation in bonus. Location, Northern New Jersey. W-7973.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after Nov. 25, 1946, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Fellow, Member, Associate, or Junior

ASHERMAN, GEORGE, New York, N. Y.
BADT, WILLIAM S., Los Angeles, Calif.
BARNEY, JOHN, Newport News, Va. (Rt)
BEARD, CHESTER S., Los Angeles, Calif.
BEAUCHAMP, JAMES M., JR., Bethlehem, Pa.
BODVARSSON, GUNNAR, Reykjavik, Iceland
BOWEN, R. TATE, Laurel, Miss.
BRESSMAN, JOSEPH R., Cleveland, Ohio
BREWER, CHARLES F., Chattanooga, Tenn.
BROSHEER, BEN C., Wheaton, Ill.
BUTLER, DON WILLIAM, Council Bluffs, Iowa
CLARK, D. F., Cayuga, N. Y.
CLEM, EVERETT W., Shrewsbury, Mass.
CLIFFORD, E. A., Toronto, Ont., Can.
DANIEL, CHARLES E., Cambridge, Md. (Rt)
DAVIES, JAMES A., New York, N. Y.
DENMAN, WAYNE L., Chicago, Ill.
DIETZ, ALBERT G. H., Cambridge, Mass.
DOBBS, JOHN G., Rock Springs, Ga.
DOWNS, JACK EDWIN, Swampscott, Mass.
DREW-BEAR, T. D., Caracas, Venezuela
DUPREY, FRANCIS R., Quincy, Mass.
DUROVY, JULIUS, Milwaukee, Wis.
EDWINSON, F. E., Hollywood, Ill.
EISSMANN, OSWALD ERICH, Richmond, Va.
FRANKLIN, ELMER SHERWOOD, Silver Spring, Md.
GANDSEY, GEORGE E., Virginia, Minn.
GARBER, PAUL B., JR., Chattanooga, Tenn.
GILBERT, W. W., Detroit, Mich. (Rt & T)
GILGAN, M. J., Bronx, N. Y.
GIRALDI, MANLIUS J., New York, N. Y.
HEATH, DWIGHT P., South Charleston, W. Va

Hecht, Irving A., Chicago, Ill.
Heller, Herbert J., East Orange, N. J.
Henderson, James H., Chattanooga, Tenn.
Hogan, M. A., Dublin, Ireland
Holloway, Paul W., Philadelphia, Pa.
Holsten, Richard M., Jr., Schenectady, N. Y.
Howard, Marshall H., Westfield, N. J.
Hudson, J. Albert, Chattanooga, Tenn.
Huer, George, Chattanooga, Tenn.
Husband, Thomas B., New York, N. Y.
Hutchings, Joseph L., Jr., Bloomfield, N. J.
Jenkins, Francis H., Appleton, Wis.
Johnston, Bruce, Bethlehem, Pa.
Jordan, Daniel J., Jr., Brooklyn, N. Y.
Jurasz, Karol O., Washington, D. C.
Kennedy, F. T., Grand Rapids, Mich.
Knell, H. J., West Caldwell, N. J.
Kostiw, William Basil, Corona, N. Y.
Langer, George B., Santa Ana, Calif.
Langhammer, A. J., Detroit, Mich. (Rt)
Lathrop, Harold F., Grabill, Ind.
Leach, Pembroke O., Chattanooga, Tenn.
Littlefield, Virgil Cleyborn, Houston, Texas
Loo, S. M., New York, N. Y.
Loomis, Glenn M., Kenmore, N. Y.
Lubahn, J. D., Schenectady, N. Y.
Luykx, D. J., Boston, Mass.
Marlowe, Donald, Silver Spring, Md.
Mauro, Francesco, Milan, Italy
Mayer, Joseph J., Buffalo, N. Y.
McDermott, William Barr, Tulsa, Okla.
Mead, Harold W., Madison, Wis.
Meyer, Robert A., Manhasset, N. Y.
Mink, Robert J., Elgin, Ill.
Moody, Wayne C., Tulsa, Okla.
Neumunz, George M., Palisade, N. J. (Rt)
Northington, S. C., Chattanooga, Tenn.
Nowak, Karl G., Beverly, Mass.
Parker, R. F., Freeport, Texas
Parker, Richard L., Chattanooga, Tenn.
Pelletier, Daniel S., New York, N. Y. (Rt)
Pentz, Norbert E., Chicago, Ill.
Perin, Raymond J., San Mateo, Calif. (Rt & T)
Peters, William W., Erie, Pa. (Rt & T)
Phillips, William F., Houston, Texas
Pogue, R. B., Mahwah, N. J.
Pollard, J. H., Houston, Texas (Rt & T)
Potter, Kenneth F., St. Paul, Minn.
Ragland, Benjamin, Chicago, Ill.
Rankin, Edward H., New York, N. Y.
Ranwez, Jean Louis, New York, N. Y.
Raynes, Burt, San Diego, Calif.
Renwick, R. J., Riverside, Ont., Can.
Rhoades, Lee A., Culpeper, Va.
Richards, Charles E., East Cleveland, Ohio
Riley, D. H., Jr., Oak Ridge, Tenn.
Ruden, Sol, Jersey City, N. J.
Savage, Robert H., Rivera, Calif.
Schipper, John F., Torrington, Conn. (Rt)
Seay, J. D., Jr., Kingsport, Tenn.
Shortt, T. C., Cleveland, Ohio
Shybekay, Derso, Minneapolis, Minn.
Sibley, William H., Marietta, Ga.
Sidebottom, Omar M., Urbana, Ill.
Spencer, Elwin Arthur, Belle Vernon, Pa.
Spielman, Maurice, Chicago, Ill.
Sullivan, Robert P., Chattanooga, Tenn.
Taylor, Sydney J., Adams, Mass.
Thomas, Charles C., West Medford, Mass.
Thompson, John Hiehle, Bellevue, Pa.
Thurston, Paul A., Washington, D. C.
Tingley, Kenneth L., Waterbury, Mass.
Umbenhauer, M. S., Brooklyn, N. Y.
Vander Ploeg, Peter F., Chicago, Ill.
Venn, Rollo E., Stillwater, Okla. (Rt & T)
Weishampel, John A., Ada, Ohio
Willy, A. Ralph, Indianapolis, Ind.
Wright, Joe M., Chattanooga, Tenn.
Yost, George E., Pensauken, N. J.
Young, George, Los Angeles, Calif.

CHANGE IN GRADING

Transfers to Fellow

Berry, C. H., Belmont, Mass.
Breer, Carl, Grosse Pointe, Mich.
Bursley, Joseph A., Ann Arbor, Mich.
Campbell, E. D., New York, N. Y.
Daniels, George C., Jackson, Mich.
Dirks, H. B., East Lansing, Mich.
Esselstyn, Horace H., Detroit, Mich.
Ford, Henry, Detroit, Mich.
Hardin, Frank H., DeKalb Co., Ga.
Hawley, Ransom S., Ann Arbor, Mich.
Irwin, K. M., Philadelphia, Pa.
Johnson, R. P., Philadelphia, Pa.
Keller, K. T., Detroit, Mich.
Kettering, Charles F., Detroit, Mich.
Mott, Charles S., Detroit, Mich.
Newman, W. A., Montreal, Que., Can.
Parker, James W., Detroit, Mich.
Sheehan, W. M., Eddystone, Pa.
Thompson, Paul W., Detroit, Mich.
Trumbull, Alonzo G., Cleveland, Ohio
Vincent, Jesse G., Detroit, Mich.
White, Albert E., Ann Arbor, Mich.
Willcox, George B., Saginaw, Mich.
Woolson, Harry T., Detroit, Mich.
Zeder, Fred M., Detroit, Mich.

Transfers to Member

Acomb, William E., Seattle, Wash.
Atwood, Hugh M., Scotia, N. Y.
Booth, Howard W., Braddock, Pa.
Brady, James V., New York, N. Y.
Brown, Wilmott, Fitchburg, Mass.
Brummerstedt, Egon F., New York, N. Y.
Budenholzer, R. A., Chicago, Ill.
Campbell, Colin G., Orillia, Ontario, Can.
Charlesworth, Roger B., South Orange, N. J.
Davies, William M., Jr., Saylesville, R. I.
DeLong, Arthur F., Oreland, Pa.
Dexter, Charles F., Portland, Maine
Engdahl, Richard B., Columbus, Ohio
Gilbreth, Frederick M., New York, N. Y.
Glassco, James B., Los Angeles, Calif.
Gunther, Carl, Rutherford, N. J.
Henrikson, William, Canton, Mass.
Hill, George B., Ottumwa, Iowa
Hinkle, Rolland T., Ithaca, N. Y.
Holbrook, Gordon E., Indianapolis, Ind.
Jennings, Uel P., Sewell, N. J.
Keim, C. J., Oil City, Pa.
Lucas, W. F., Louisville, Ky.
Meredith, Henry H., Jr., Encino, Texas
Michetti, Albert L., Baltimore, Md.
Muller, George J., Philadelphia, Pa.
Parrish, William C., Inglewood, Calif.
Petzholt, Edmund J., Williston Park, N. Y.
Prohaska, James J., Palos Heights, Ill.
Schroeder, Wilbur C., Toledo, Ohio
Selva Fernandez, Aurelio, Matanzas, Cuba
Setchell, John Stanford, Babylon, N. Y.
Silver, Francis, 5th, Martinsburg, W. Va.
Spruitenburg, M. J., York, Pa.
Steinmetz, A. M., Cedar Grove, N. J.
von Bremen, D. W., Jr., Whitestone, N. Y.

Transfers from Student Member to Junior......86

Necrology

THE deaths of the following members have recently been reported to headquarters:

Cutler, Arthur E., July 11, 1945
Evans, George B., September, 1946
Fairhurst, Thurstan W., June 15, 1946
Felgar, James H., August, 1946
Heffernan, John T., June 17, 1946
Heftler, Victor R., September 16, 1946
Johnson, Hamilton, June, 1946
Kice, Murray S., September 25, 1946
Roberts, Arthur R., September 6, 1946
Rothmaler, Oswald, July 12, 1946
Sackett, Robert L., October 6, 1946
Schwendler, Richard H., August 10, 1946
Scudder, Charles M., July 12, 1946

A.S.M.E. Transactions for October, 1946

THE October, 1946, issue of the Transactions of the A.S.M.E. contains the following papers:

TECHNICAL PAPERS

- The Design of Mechanical Auxiliaries for TVA Hydroelectric Plants, by H. J. Petersen
- A Better Method of Representing and Studying Water-Turbine Performance, by R. A. Sutherland
- Nantahala Turbine, by J. P. Growdon, R. V. Terry, and H. H. Gnuse, Jr.
- New Developments in Combination Controls, by J. W. Kelly
- The Effect of Measurement Dead Time in the Control of Certain Processes, by D. P. Eckman
- Mechanical Oscillators and Their Electrical Synchronization, by S. W. Herwald, R. W. Gemmell, and B. J. Lazan
- Precision Tachometer for Use in Wind-Tunnel Testing, by R. K. Fairley and H. L. Clark
- Electromagnetic Torquemeter, by M. W. Hively and D. F. Livermore
- Taking the Mystery Out of the Kadenacy System of Scavenging Diesel Engines, by P. H. Schweitzer, C. W. Van Overbeke, and L. Manson
- An Analysis of Intercooled Supercharging, by R. H. Miller
- Bavarian Motor Works Altitude-Test Facilities, by E. E. Stoeckly
- Peanut-Meal Plywood Glue, by R. S. Burnett and E. D. Parker
- Locomotive Fuel From the Coal-Man's Viewpoint, by C. F. Hardy
- A Failure-Sequence Indicator for Static Test Specimens, by R. W. Powell
- Laminated Edge Attachment for Acrylics, by E. H. Snyder
- Rotational Drop-Testing of Airplane Main Landing Gear, by W. H. Gayman
- Some Suggested Specifications for Thermal Ice-Prevention System for Aircraft, by L. A. Rodert